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## **HOW BIG DATA CAN INFLUENCE TERTIARY EDUCATION CURRICULUM TO INCREASE EMPLOYABILITY RATES**

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I certify that this work has not been submitted for a higher degree before and I have referenced all sources and the extent to which I have used them. I also certify that this work has been reviewed by my supervisor prior to its submission. Ethics approval has been granted for this project but was not used for this research paper. The ethics approval reference number is: 5201835436584.

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## Abstract

This research project seeks to examine the current tertiary educational curriculum and identifying its limitations through the adaptation of Big Data in the educational review process. This will not only identify the current problems with the educational curriculum but also assist in creating new strategies to improve it. The aim of this research project is to enhance the current educational program to increase the employability rates for graduates by matching the requirements of the workforce. This research project aims to deploy new strategies in-order to improve current limitations, thus ensuring maximum employability rates are accomplished post-tertiary education. The full-time employability rate for those with undergraduate degrees in New South Wales (NSW) has decreased since 2008 (Singhal, 2019), which demonstrates how competitive the current employability world is and the importance of why educational curriculum needs to be kept up to date on what is taught. Thus, the adoption of Big Data in the review process of curriculum can assist in ensuring that institutions are kept up to date, and graduates are work-ready.

**Keywords:** Big Data, Education, Employability, Curriculum, Literacy Learning Outcomes

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## List of Abbreviations

NSW	New South Wales	PACE	Professional and Community Engagement
ARWU	Academic Ranking of World Universities	PhD	Doctor of Philosophy
BCE	Before the Common Era	QS	Quacquarelli Symonds
IS	Information System	UNSW	University of New South Wales
IT	Information Technology	UTS	University of Technology Sydney
KPI	Key Performance Indicators	WSU	Western Sydney University
MRES	Master of Research		

# 1. Introduction

Education is an essential part of any individual's lifestyle today, as it provides both the knowledge and the skills to develop one's own perspectives at looking at different things throughout life. Tertiary Education allows people to critically think, analyse problems and come up with conclusions from supporting evidence on their own. There is a wide variety of disciplines for people to learn and establish new skills in today's era, including but not limited to: business, law, medicine, media, engineering, education, information technology, history, etc. Today, across these sectors, organisations aim to maintain competitive advantage by collecting, identifying and analysing data. This is otherwise known as Big Data. There are many challenges associated with Big Data and some of these challenges are defined through the "5Vs" of Big Data which include: volume, variety, velocity, veracity and value of data. Despite the challenges associated with Big Data, the benefits and the insights gained are far too valuable.

This research project seeks to examine the current university curriculum, identify its current limitations, and come up with new strategies to improve these limitations, thus ensuring maximum employability rates are accomplished post-tertiary education. The combination of Big Data within the tertiary educational sector creates a next level of understanding, as it generates better prediction of trends, thus allowing effective changes to be made to the current education curriculum. This research aims to fill the gap in the market by identifying the challenges and developing a matrix to assist current education sector to improve tertiary education curriculum, that will assist in increasing employability rates post-graduation. This helps maintain and develop the economic wellbeing of the individual and society in general.

## 2. Background

Today, the employment sector is becoming extremely competitive, and in-order to increase employability rate for graduates, this research project will examine ways to improve the current university curriculum to match the curriculum with the skills that employees are looking for. It is important that institutions (namely Universities) do not fall behind and keep up to date on what is taught in this competitive world, and thus the adoption of Big Data in the review process of curriculum can assist in ensuring that institutions are kept up to date. It is essential that all education curriculum is continuously being reviewed, and suitable modifications are being made to adapt to the changes of the world. This is extremely important within the information technology (IT) sector; as technological advancements are continuously growing. By reviewing the current education curriculum, it allows institutions to identify the gaps and weaknesses in-order to develop and improved educational curriculum for the future.

Big Data is defined as large amount of data sets that can be used for analysing data to assist in making better management decisions (Manyika et al., 2011). Today, organisations can enhance their competitive advantage by collecting, identifying, analysing and evaluating the data that is collected from their target audience. The collection and analysis of data in organisations can assist in predicting future trends, and tailor the demands of the customer in-order to maintain competitive advantage (Eriksson, Forsström and Rosenbröijer, 2016). The data analysis ensures that organisations collect more accurate and detailed data in real or near real time (Manyika et al., 2011), In this case, the Department of Education staff would have unprecedented access and insight into the data collected from current students, alumni and those in the workforce. This research project will investigate how Big Data can be used to enhance the educational programs at a university level to increase employability rate by ensuring that requirements of the educational organisations are matched with the skills required by employers. By using the concept of Big Data within the educational sector, this research will aim to better develop university curriculums in-order to meet the requirements of hirers.

Every new generation has found it is a necessity to pass on its accumulated knowledge, skills, values, and traditions over generations (Dewey, 1923). As the world developed to what it is today, more formal like institutions started being built to ensure that people had a basic and uniform standard knowledge of subjects universally, which can further assist in career development and employability. With the continuous advancement of the world, especially within the IT sector, the



educational curriculum also needs to advance to keep up with the world. The development of technology grew from the introduction of the World Wide Web in 1992 (Lumsden, 2017). The introduction of the World Wide Web has resulted in an exponential growth of data due to the availability of a wide variety of sources (Ahmadi, Dileepan and Wheatley, 2016). Currently, there is approximately 4.1 billion internet users (and increasing) from a continuously growing population (~7.7 billion) (Stevens, 2019, World Population Review, 2019). The development of the World Wide Web has revolutionised the way the world operates today and plays a pivotal role in today's daily lives in a variety of different purposes (Lumsden, 2017).

Organisations are now using Big Data to assist in improving their planning and decision-making processes, thus providing a new set of opportunities to a range of industries and departments. When Big Data is effectively and efficiently captured, processed, and analysed, organisations are then able to visualise a more complete picture of their organisation (Navint, 2012). This data, is then used to improve customer service, products and services (Manyika et al., 2011). In the same way, Big Data can influence the education sector as they are able to gain a more complete picture of the skills employers are currently looking for which in turn can better assist in improving educational curriculum, thus leading to an increase in employability rates for university graduates.

However, today, the biggest problem with Big Data is understanding and making sense of large amounts of data which is now being generated at an exponential rate. Each university and organisation offer many different courses, degrees and units they offer in-order to achieve an advantage over their competition institutions. This can also mean that the structure of the curriculum may vary from institution to institution. However, despite these differences, they will also have some standardised criteria to follow that's set by national government of the country. The analysis of big data will better assist in identifying these standardised criteria, the current issues and thus allowing the current university curriculum to be modified in-order to reduce the flaws. These are just some of the problems associated with Big Data, and more detail of these challenges will be explored through the "Vs" of Big Data.

### 3. Project Aims

The aim of this literature review is to: (1) Identify the importance of Big Data, (2) weaknesses of the current educational system, and (3) the potential changes to the curriculum that need to be made in-order to increase employability rates upon graduation of tertiary education. This research will examine and explore the challenges that the department of education, institution and/or other organisations might face when using Big Data. Four research questions have been developed so that they can be investigated in detail for this research manuscript:

1. What are the challenges of Big Data?
2. What are challenges of the current educational curriculum?
3. How can a Big Data assist in improving the current university educational curriculum?
4. Is there a correlation between educational curriculum and current employability rates for graduates?

## 4. Significance

The significance of this research relies on creating a contribution to knowledge and a deeper understanding of Big Data and its affects to an organisation. This is done through the process of identifying and gathering relevant data in-order improve an organisations efficiency by making more informed decisions. IBM Global Business Services (2013) demonstrates that 19 per cent organisations that use Big Data for decision making have a competitive advantage over their competitors. The key value in decision making is to determine the past trends and use these for future planning. However, challenges of the petabyte age is faced with approximately 2.5 quintillion bytes ( $10^{18}$ ) of data being created almost every day by users (Barnes, 2013). Due to this immense number, coming up with a standardised tertiary curriculum worldwide is difficult. Education is important, as not only does it teach individuals the life skills needed to survive today, but also to make better judgement and maintain a healthy economic wellbeing globally.

The correlation between education and employability has not been explored by this technique and this is the research gap we are exploring. Every employer is looking at an individual's education as well as determining the life skills that have developed that individual along the way. Employers and organisations are looking at students who have gone beyond the university curriculum and can demonstrate the ability apply the knowledge learnt successfully within the practical life. Today the full time employability rate for those with undergraduate degrees in NSW is around 73 per cent according to the 2018 Graduate Outcomes Survey, which is a decreased from as high as 85.2 per cent in 2008 (Singhal, 2019). This shows how competitive the current employability world is and the importance of why educational curriculum needs to be improved to bounce back the employability rates post-tertiary education. Thus, the significance of Big Data to assist university curriculum is quite significant, so that currents flaws can be determined and improved so that employability rates for current tertiary graduates can increase. This increase will also assist the country's economic wellbeing.

## 5. Literature Review

### 5.1. Big Data

Big Data has become a common overused term, created in the last decade that aims to give organisations a competitive edge over each other (Provost and Fawcett, 2013). There is no universal agreement on the definition of Big Data (Ahmadi, Dileepan and Wheatley, 2016) as organisations perceive the importance and challenges of Big Data differently. Chen, Mao and Liu (2014) describe Big Data as enormous datasets, whereas Boyd and Crawford (2012) not only refer to the terminology as very large data sets, but rather about a capacity to search, aggregate, and cross-reference large data sets.

#### 5.1.1. Importance

Organisations are using Big Data to assist in improving their management decision, and thus providing new set of opportunities to a range of industries (Ahmadi, Dileepan and Wheatley, 2016). Data collection and analysis ensures that organisations can collect more accurate and detailed performance data in real or near real time (Manyika et al., 2011), thus providing massive insight (Nasser and Tariq, 2015) assisting organisations in improving the quality of products and services. Big Data allows organisations to observe potential insights and trends (Boyd and Crawford, 2012) to predict future trends. It provides organisations the ability to make more informed decisions based on the data and trends collected to minimise the risks and identify new opportunities. When Big Data is effectively and efficiently captured, processed, and analysed, organisations are able to gain a more complete picture of their organisation, customers, products, and competitors (Navint, 2012). This can lead to increased sales, better customer service, and improved products and services as the organisation's tailor products and services, uniquely to their customers (Manyika et al., 2011). If Big Data cannot be effectively utilised in reducing errors and improving the accuracy of the created insights, it is of no value to the organisation (Lukoianova and Rubin, 2014).

#### 5.1.2. History of Big Data

Even though the World Wide Web has resulted in the exponential growth of data being created, the term Big Data did not emerge until recently. Technically, the term of 'Big Data' was created in 2008 by Chris Anderson (Anderson, 2008) who demonstrated the evolution of the Petabyte age. The petabyte age demonstrates the storage of such large volume of data (Anderson,

2008); and the data is no longer regarded as static, but rather “raw unstructured materials” (Mayer-Schönberger and Cukier, 2013). But the concept of this exponential growth itself can go back (before the pre-Apple era) to the 1950s “where attempts were made to link large sets of data to the calculative power of the computer” (Barnes, 2013).

### 5.1.3. Growth

Big Data is expanding continuously due to an increase in affordability and improvement in technology. On top of this vast size of data, internet traffic is expected to create at about 50,000 GB/second by 2018 (IBM Big Data Hub, 2017) making the process ever more difficult. Today, the generation of data is increasing exponentially for current technologies to keep up with the load of data, and thus has become a pressing issue today. The development of the World Wide Web in 1992 (Lumsden, 2017), has resulted in the exponential growth through worldwide use of internet as massive amounts of data from a wide variety of sources are being created and collected every second by businesses and organisations and analysed in near real time (Ahmadi, Dileepan and Wheatley, 2016). Moore’s Law predicted that the “number of transistors per chip would double each year” (Coffman and Odlyzko, 2002), which has been sustained over the latest few years. Persistent growth of the internet has resulted in not only the development of data but also a plethora of different technologies. Some of these include hard disks, browsers, networks, bandwidth to meet the demand of the users on a daily basis (Coffman and Odlyzko, 2002).

In 1991, Michael Noelle estimated the maximum volume of data transfers has exceeded the original prediction, mainly due to the unforeseen development of graphic-rich content such as Web Pages, as it was assumed that only text will be transmitted and processed (Coffman and Odlyzko, 2002). Today, data can be created from a variety of different sources such as social media posts (text), digital media, blogs, videos and pictures (Boyd and Crawford, 2012). The development of the World Wide Web has revolutionised the way the world operates in all aspects of the environment today and plays a pinnacle role in today’s daily lives for a variety of different purposes.

### 5.1.4. Benefits

Now, organisations can analyse data, predict future trends, and are able to maintain competitive advantage by collecting, identifying, analysing and evaluating the data. The collection and analysis of data assists organisations to predict future trends, and tailor the demands of the customer in order to maintain competitive advantage (ErikssonForsström and Rosenbröijer, 2016). The collection and analysis of data is important in order to predict future trends, and tailor the

demands of the customer in-order to maintain competitive advantage. IBM Global Business Services (2013) demonstrates that 19 per cent organisations that use Big Data for decision making have a competitive advantage over their competitors. Big Data is to gather, collect and analyse the relevant data in order to assist in making better management decisions (Manyika et al., 2011). Today, we collect and share data by making the process much simpler, allowing data to be collected in real time and thus allowing a more data-driven and agile decision-making approach (Chatfield et al., 2014). Organisations are using Big Data to assist in improving their planning and management decision, and thus providing a new set of opportunities to a range of industries. Data collection and analysis ensure that organisations can collect more accurate and detailed data in real or near real time (Manyika et al., 2011), thus, providing massive insight (Nasser and Tariq, 2015). Today, the main job of managers is to ensure that the right decisions are being made in a timely manner for the project and organisation (Eriksson, Forsström and Rosenbröijer, 2016). When Big Data is effectively and efficiently captured, processed, and analysed, organisations are able to gain a more complete picture (Navint, 2012), which, in turn, improve customer service, products and services (Manyika et al., 2011). Data has become “key building block for decision-making” (Eriksson, Forsström and Rosenbröijer, 2016). If Big Data cannot be effectively utilised in reducing errors and improving the accuracy of the created insights, it is of no value.

#### 5.1.5. The Vs

This petabyte age of data generation has resulted in a variety of new definitions of the term Big Data due to the evolution of technology (Goes, 2014). It can possess different features and characteristics, which affect its quality. The features of Big Data can vary across many dimensions which can be defined by its challenges and opportunities through the 3Vs model that was demonstrated by Doug Laney in 2001 (Laney, 2001). This 3Vs model was used by “many other enterprises, including IBM and some research departments of Microsoft” and is still currently used today (Chen, Mao and Liu, 2014). The three elements derived from Gartner’s 3Vs Model includes Volume, Variety and Velocity (Laney, 2001, Nasser and Tariq, 2015) and are vital characteristics to demonstrate Big Data. As technology progressively advanced so did the definition of Big Data, where the 3Vs evolved into 4Vs through the introduction of ‘Veracity’ in 2012 (Chen, Mao and Liu, 2014, Ward and Barker, 2013). Today, a fifth category of ‘Value’ has been added to further define the term ‘Big Data’ (Chen, Mao and Liu, 2014). In this report, only these five Vs are examined.

<b>Dimension</b>	<b>Definition</b>
<b>Volume</b>	Volume refers to the vast scale of data created. One of the primary challenges of Big Data is being able to handle and store such large amount of data (Katal, Wazid and Goudar, 2013), especially in comparison to the resources available. The volume of data is enormous and a very large contributor to the ever-expanding digital universe, with data being created all over the world through a variety of devices every second. The struggle that organisation's face is that capturing, managing, processing and analysing all this information can be difficult due to the volume of the data being too large (Navint, 2012).
<b>Variety</b>	Variety refers to the different types of data available, as data is no longer only in its traditional form due to the advancement of technology. Data can be in the form of structured, semi-structured and unstructured data (Batini and Scannapieco, 2016, Mayer-Schönberger and Cukier, 2013, Sagioglu and Sinanc, 2013) due to the various resources available today such as web pages, images, blogs, email, social media sites (Katal, Wazid & Goudar, 2013, Ward & Barker, 2013). However, majority of the information available are unstructured or semi-structured data, which makes the process of data analysis more difficult for organisations to deal with (Baars & Kemper, 2008).
<b>Velocity</b>	Velocity refers to the speed of data being created (Katal, Wazid & Goudar, 2013). On top of the volume of data, the data is also being created way too fast for current traditional technology to understand, and thus making the process even more challenging. Today, the speed of data flow is accelerating, and it is estimated that the speed of global internet traffic will be approximately 50,000 GB/second by 2018 (lbmbigdatahub.com, 2018).
<b>Veracity</b>	Veracity refers to the level of reliability of data available due to uncertainty and biasness of data that can occur (Lukoianova and Rubin, 2014, Nasser and Tariq, 2015). This can be a result of inconsistency and incompleteness of the data available. It is important to separate certain and uncertain data for a more accurate representation of data as process becomes more complex for organisations to measure as more uncertainties arises especially with non-numerical text.

**Value** Value refers to converting the raw data into valuable information during data analysis. It is essential that the data gathered is relevant and of quality towards the business and is not just a large amount of worthless quantity of data that cannot provide any valuable insight. Data without being converted and analysed is useless to the organisation, and only results in a waste of time, cost and storage (Chen, Mao and Liu, 2014)

*Table 1 - Dimensions of Big Data - 5Vs*

As technology develops, Big Data expands, and the dimensions of Big Data will not only keep expanding but also will become more and more complex. There is talk of expanding the Vs to 7-10Vs to properly define the dimensions of Big Data which include: Variability, Visualisation, Validity, Vulnerability and Volatility. These are briefly discussed in Table 2, but will not be a focus of this report, and acknowledged as limitations of this study.

Dimension	Definition
<b>Variability</b>	Meaning of data that is changing constantly and rapidly especially in relation to language process (McNulty, 2017).
<b>Visualisation</b>	Converting this raw data into a more presentable manner (such as through simple and complex charts and graphs) (McNulty, 2017).
<b>Validity</b>	Correct and accurate data that is intended to be used (Normandeau, 2017).
<b>Vulnerability</b>	Exposure of sensitive data being attacked as the data captured, stored and analysed needs to be taken in consideration (Cxotoday.com, 2017).
<b>Volatility</b>	How long a data is valid and how long should it be stored (Normandeau, 2017) to determine at what point data is no longer relevant to the current analysis for the project or organisation.

*Table 2 - Future Dimensions of Big Data*

#### 5.1.6. Challenges

Despite the several benefits of Big Data for the management of organisations, there are numerous challenges associated with it. These challenges are described through the five dimensions (5V's) of Big Data: Volume, Variety, Velocity, Veracity and Value (Laney, 2001, Nasser and Tariq, 2015) which is described in detail in Table 2. Today, the biggest problem with Big Data is making sense of the insights gathered from the large amounts of data, which is being generated at an exponential rate whilst maintaining privacy. The analysis of this data identifies the risks that companies might face.



Big Data is a valuable resource that can provide insights to help us understand complex systems and lead to better decisions there are many challenges to dealing with Big Data. Being aware of these challenges reduces the risks and better prepares organisations of what to expect. Organisations are increasingly investing in technology to collect, store, and process vast quantities of data. Despite this, they often find themselves obstructed in their efforts to translate this data into meaningful insights that they can use to improve business processes, and make smart decisions. (Madnick et al., 2009). Inconsistency with the data collection process due to the volume of the data being too large which echoes similar findings by Chen, Mao and Liu (2014) in regards to the difficulty in storing meaningless data. Due to this inconsistency, some of the data collected may not show the entire picture, as it may be lost. Challenges of Big Data include: Incorrect Data Entry, Storage of Data, Server Overload, Natural Disasters, Misuse of confidential information, Loss of backup files etc. These are all critical challenges that have huge consequences on an organisation and are examined in detail below.

#### 5.1.6.1. Handling Large amounts of data

One of the primary challenges of Big Data is being able to handle and store such large amount of data securely (Katal, Wazid and Goudar, 2013).

#### 5.1.6.2. Capturing Information

Capturing, managing, processing and analysing information can be difficult due to the volume of the data being too large (Navint, 2012).

#### 5.1.6.3. Rapid development of technology

Overwhelming data flow generation has resulted in the evolution of computing architecture and data processing mechanism (Chen, Mao and Liu, 2014). But despite this development, the rate of data being created is way too fast for technology to be able to keep up (Tole, 2013).

#### 5.1.6.4. Data is captured from a variety of different sources and formats

Data can be in the form of structured, semi-structured or unstructured (Batini and Scannapieco, 2016, Mayer-Schönberger and Cukier, 2013, Sagioglu and Sinanc, 2013) due to the various resources available today such as web pages, images, social media sites (Katal, Wazid and Goudar, 2013). Majority of the information available are unstructured or semi-structured, which makes the process of analysis more difficult (Baars and Kemper, 2008).

#### 5.1.6.5. Speed of Data being generated

On top of the volume of data, the data is also being created way too fast for current traditional technology to understand, and thus making the process even more challenging. This can also result in server shutdowns, slowdowns and difficulty in analysing important information.

#### 5.1.6.6. Data Quality

Data gathered should be of quality to the organisation which can be measured by: (1) accuracy, (2) completeness, (3) timeliness, (4) consistency, (5) accessibility and (6) reliability (Batini and Scannapieco, 2016, Lee et al., 2002). Due to the large amount of data being created at a such fast pace through a variety of sources, organisations find it difficult to translate the raw data into meaningful information (Madnick et al., 2009). Data quality is a multi-dimensional concept where companies need to deal with individuals' involve as well as the raw data (PipinoLee and Wang, 2002). The dimensions of data quality are examined below:

- **Accuracy:** The extent to which data is correct, reliable and free of error (Batini and Scannapieco, 2016). This includes ensuring there is no human or systematic errors in the data through duplication, omission, replication etc.
- **Completeness:** Refers to the extent to which data is not missing (Pipino, Lee and Wang, 2002), in-order to ensure that there is enough data for an unbiased analysis.
- **Timeliness:** Ensures that the data is up-to date and implies that data is current in correspondence to the usage (Batini and Scannapieco, 2016)
- **Consistency:** Absence of difference by ensuring that the data represented is in the same format, and portrays the same value of information through-out (Pipino, Lee and Wang, 2002).
- **Accessibility:** Refers to how readily available data is and how quickly it can be retrieved (Batini and Scannapieco, 2016).
- **Reliability:** Refers to the stable and consistent data collection process over time
- **Uniqueness:** Ensuring that the data collected does not have duplications.

It is essential that the data collected and analysed are of quality, so that the stakeholders assessing the product do not have a negative reputation for the organisation which could result in negative outcomes.

#### 5.1.6.7. Data Privacy and Security

Data privacy and security is a major concern as organisations capture and store a range of individual's information data in-order to gain a competitive advantage. Protecting privacy is becoming more of a challenge today as information is rapidly increasing and shared around the globe (Tene and Polonetsky, 2011). This has resulted in more exposure of sensitive information and thus become more difficult to manage (Chen, Chiang and Storey, 2012). Organisations needs to be prepared to defend themselves against illegal activities and advanced cyber threats, especially if all the data is kept in one place as that makes the organisation more vulnerable (Tene and Polonetsky, 2011). Security advancements such as passwords, access controls, and encryptions have been implemented by organisations, however over the past few years, technology is becoming more and more advanced making it difficult for organisations to defend themselves.

Recently a new ransomware known as WannaCry affected hundreds of thousands of computers worldwide. The WannaCry has the ability to express itself across the network of organisations and asks users to pay a US\$300 ransom in bitcoins (Symantec Security Response, 2017). The ransomware became an issue when it hit the UKs public health system of Friday, 12th of May 2017 and affected more than 200,000 computers worldwide and 150 countries (SearchHealthIT, 2017). These computers and data are vulnerable by attacks such as WannaCry ransomware due to the challenges associated with managing Big Data, especially as Cyberattacks such as like these are going to continue and get worse and disruptive to organisations. These external breaches not only impact business but it is important to use this value information to better prepare a risk management plan to avoid future attacks.

#### 5.1.7. Different Sectors using Big Data

Almost every organisation is now using Big Data to maintain a competitive edge, thus improving their operational efficiency and bottom line. Some of these sectors that use Big Data, include but are not limited to: education, government, and sports sectors. Each of these different areas uses Big Data uniquely to benefit their organisation. This paper will specifically focus on the education sector.

##### 5.1.7.1. Education

The education sector uses Big Data to gain insight about students and teachers to enhance the learning experience. This sector includes Primary School, High School, TAFE, University, Tutoring

Centres, and Online courses. A collection of past information, as well as feedback is commonly used to create lesson plans, determine study patterns of student performance over time, improve services and administrative decisions (Picciano, 2012). This research paper will specifically focus on the undergraduate study at universities.

#### 5.1.7.2. Government

The government industry historically has generated large amounts of data, driven by record keeping about individual's in-order to efficiently to improve quality whilst reducing. Data is gathered to create a more personalised service. The biggest impact of Big Data within the Australian Government can be seen through the census, which collects a variety of information about the population to better tailor the services and products that each individual community requires. The government can use this wide vast of data to create new legislations based on the demands and needs of the Australian community, create hospitals or schools in suburbs in need, or accommodate for the ageing population.

#### 5.1.7.3. Sports

There are multiple dimensions of sports that use Big Data, in order to collect statistics about players, specific games, and opponents' in-order to better create game plans to ensure a maximum win for any game. This could be, and not limited to Cricket, Soccer, Football, Hockey, Tennis etc. A lot of the data is collected for the team's own strategy, but others are also collected for the viewers such as for those interested in betting. This is to better understand how Big Data is used in the sporting industry.

## 5.2. Education

Seeking an acceptable definition of education can be difficult as there are a range of different definitions, from the most basic dictionary ones to more detailed discussions. The conventional definition of education is the acquisition of knowledge through the reading of books, and the learning of facts (Roosevelt, 2008). Another definition is the process of facilitating learning, or the acquisition of knowledge, skills, values, beliefs and habits (Dewey, 1923). Regardless of the definition one deems most appropriate, education is important for individual's development in life, career and for the society in general as it provides individuals with the required skills and knowledge to compete in the current world.

Education can take place in both a formal and informal setting. Today, formal education can be commonly categorised into different stages depending on the culture and country. The common stages of education in today's society generally include: primary school, secondary school and then college, university, TAFE or other tertiary education, before undergoing a career. Formal education allows students to develop skills and abilities of general value, which can be used to solve a wide range of problems as schooling builds skills, abilities, and resources on several levels. Formal education allows people to "learn to read, write, analyse, communicate, negotiate, solve problems, look things up, figure things out, plan, persevere, trust others, work with colleagues, and develop ideas" (Kingston et al., 2003). It is believed that the higher the level of education, the greater the cognitive development (Ross and Mirowsky, 2010) as the complexity of study increases, thus allowing people to think more logically and rationally. This allows individuals to see different perspectives of an issue, and to analyse and solve problems (Kingston et al., 2003, Pascarella, 2006). Apart from the value of the skills and abilities learned through institutions, the process of learning develops individuals' habits and attitudes such as "dependability, judgment, motivation, effort, trust, and confidence" (Barkan, 2016). Education provides the fundamental framework for people to develop important skills needed to make effective decisions on a day to day basis.

Higher education institutions are under increasing pressure to better prepare their graduates for the workforce (Ryan, Toohey and Hughes, 1996). Within professional courses, a practical nature within the curriculum continues to be an essential means to address this expectation. Depending on the discipline, the practicum appears in many forms: as field or clinical placement, sandwich program, internship, clerkship or other practical engagements (Ryan, Toohey and Hughes, 1996). It is important to keep in mind that the skills individuals gain is not solely

dependent on institutions such as school, college and university, and can also be from other informal perspectives as well such through the upbringing at home, storytelling and other aspects of personal background. Regardless of the type of education received, every tiny bit of knowledge and skills accumulated are vital for the character development of an individual and shape their understanding of the world.

### 5.2.1. Growth of education

Education dates back to the very first humans ever to inhabit Earth. In order to survive, every generation has found it is a necessity to pass on its accumulated knowledge, skills, values, and traditions to the next generation. For hundreds of thousands of years, children educated themselves from their ancestors through a variety of methods such as self-directed play and exploration (Gray, 2008). Back in the early days it may not have been formal education, but it was a means of learning in order to survive that situation of the world. As the world developed to what it is today, more formal institutions started being put in place to ensure that people had the basic and standard knowledge of subjects throughout, which can further assist in career development and employability.

Whilst the earliest forms of written communication dates back to about 3,500-3,000 before the common era (BCE), education was restricted for centuries as it was closely associated with power and high class (Roser and Ortiz-Ospina, 2019b). It was only in the Middle Ages that literacy among the general population slowly started becoming incorporated (Roser and Ortiz-Ospina, 2019b). However, since then the world has undergone a great development in education, especially within the past two centuries. Today, children are required by law to go to school and almost all schools are structured in the same way (Gray, 2008).

The first tertiary education developed is the University of Bologna which was founded in 1088 (Encyclopaedia Britannica, 2019) . The university is located in Italy and is one of the most prestigious universities both in Italy and Europe. Since its development many other universities have been formed world-wide such as Harvard University (United States), University of Oxford (United Kingdom), University of Malaya (Malaysia), Macquarie University (Australia) etc. The growth of tertiary education has dramatically increased since the first development, due to the importance of education for the society, and to ensure employability. This research paper will be focusing specifically on tertiary education and understands that it may be a limitation of this report.

### 5.2.2. Benefits of Education

The purpose of education is to teach one to think intensively and critically, as education assists in partially shaping people's opinions. It allows people to be able to process and make informed choices in order to assist in development of their own. The more educated a person is the more knowledge, skill, and training they will have accumulated in order to search, process, and use the information in a more efficient manner compared to those who have received less education (Vila, 2000). Individuals change overtime as they accumulate more of these knowledge and skills, thus adopting a wider perspective on life which makes education beneficial to gain a competitive advantage in today's world. There are a range of benefits and importance for education as people develop their own lifestyle through the accumulated knowledge.

Some of the major effects of education goes beyond the benefits of income and economic productivity. These effects can affect the individual educated and/or affect others through markets and through mechanisms external to markets with whom educated individuals come into contact with (Behrman and Stacey, 1997). Through the process of informed choices, people develop their own lifestyle such as personal habits, education choices, family type, occupational status, health standards and consumption behaviour. (Vila, 2000). Below are some of the benefits of education, however, it is important to keep in mind that education and is just one amongst many other factors, such as innate ability and family background in the development of the preferences that guide the behavioural choices described below (Table 3).

Category	Benefit
<b>Employability</b>	<ol style="list-style-type: none"> <li>1. Better educated people generally have better jobs and higher incomes than those with less schooling (Ryan, Toohey and Hughes, 1996). Statistics show that earnings increase by approximately ten percent with each additional year of schooling (Chowdhury, 2018).</li> <li>2. Due to educated people having a greater depth of information, they undergo a more efficient and shorter job searching experience (Ryan, Toohey and Hughes, 1996, Vila, 2000).</li> <li>3. Individuals who are educated have a better expectation regarding occupational choices due to having some form of formal and/or experience within the industry. This is especially due to higher education allows people to specialize in certain fields, thereby opening numerous earning opportunities (Chowdhury, 2018) and allowing individuals a better understanding of the specialisation's requirements.</li> </ol>
<b>Society</b>	<ol style="list-style-type: none"> <li>1. Education leads to a greater labour market productivity as individuals have a better understanding on the importance of their role for the greater community.</li> <li>2. Increases individuals' wellbeing through the satisfactions obtained from income and home production.</li> <li>3. Reduction in poverty and social alienation as individuals with more schooling are generally less likely to be left behind through the development process.</li> <li>4. Educated people are generally more civilized and tolerant as school helps children to understand societal values and provides them with socially acceptable norms. Education assists in shaping people's sense of right and wrong (Chowdhury, 2018). Due to this, educated communities are less likely to experience violent social conflicts than societies with a less educated population and thus leads to less violent criminal behaviour. Society benefits from this as there are less crimes, greater sense of safety, and monetary benefits (such as lower costs of safety, protection, and law enforcement).</li> </ol>



	5. Education promotes equality between everyone and thus ensures that there are equal opportunities for everyone regardless of race, gender or social class, equal access to education.
<b>Health</b>	<ol style="list-style-type: none"> <li>1. Education is a “fundamental cause” of good health (Chang and Lauderdale, 2009). Education increases physical functioning and subjective health, and decreases the age-specific rates of morbidity, disability, and mortality.</li> <li>2. Since good health is promoted by an appropriate use of medical information and resources it allows individuals to make better nutritional choices, ensuring regular and continuous check-up routines are met, and effective exercise is performed regularly.</li> <li>3. Informed decisions mean individuals avoid drugs, such as alcohol and cigarettes due to knowing the harm it does to individuals’ body.</li> <li>4. Parental education also contributes to children's health in terms of lower infant mortality rates, and more vaccinations against contagious diseases.</li> <li>5. Individuals are more aware of work and safety hazards around them.</li> </ol>
<b>Family</b>	1. Efficient use of information related to birth control.
<b>Lifestyle</b>	<ol style="list-style-type: none"> <li>2. Education improves family lifestyle as it allows individuals to plan better. They can evaluate the costs and benefits of having children.</li> <li>3. Declining fertility rates due to reduced infant mortality and unwanted pregnancy of teenagers.</li> <li>4. The education level of the next generation is clearly influenced by the education received by their parents.</li> </ol>
<b>Economy</b>	1. Better educated society allows better infrastructure, amenities and facilities for the people such as healthcare and education.

	<ol style="list-style-type: none"> <li>2. More education directly increases the demand for items related to the acquisition of knowledge. These include: manufactured goods (such as books, stationary, computers) and complementary services (such as transport, meals, accommodation).</li> <li>3. Due to individuals having a range of perspectives based on their education, interpretation and family lifestyle it allows them to have different opinions about different types of products and services, and therefore allows for a healthy development of the industries and markets.</li> <li>4. An increase in economic growth due to access to new products, new ideas and new technology (Vila, 2000).</li> <li>5. Educated people spend a substantial part of their income on goods and services related to technology, science, literature, music, arts, travel, and other cultural activities, which, in turn, fosters the development of industries and markets (Vila, 2000)</li> </ol>
<b>Environment</b>	<ol style="list-style-type: none"> <li>1. Developing awareness about the environment and the current challenges it faces</li> <li>2. Reduction of pollution such as air pollution or water contamination</li> <li>3. Motivation to improve or maintain the environment quality</li> <li>4. More knowledgeable about sustainability in agriculture (Chowdhury, 2018)</li> </ol>
<b>Personal</b>	<ol style="list-style-type: none"> <li>1. Better communication skills (written and verbal) and critical thinking skills (analyse and to reflect)</li> </ol>
<b>Development</b>	<ol style="list-style-type: none"> <li>2. Greater sense of discipline and responsibility</li> <li>3. Build self confidence</li> </ol>

*Table 3 - Benefits of Education*

The importance of education cannot not be overstated as education has many positive impacts throughout people's lives, and these effects are evident in many other ways other than higher income. However, it is important to note that education is not the sole factor for these benefits and that a variety of factors outside of education, such as family and peers, also have a powerful influence on an individual's lifestyle.

### 5.2.3. Quality of Education

The quality of the education received by the individual indicates the validity of the institution. However, measuring the academic quality is difficult to evaluate as the quality can mean different things to different people, depending on their perspective and context. There are three main stakeholder perspectives to take in consideration when it comes to the quality of education. These include the parents, teachers and students (Layzer and Goodson, 2006). Each of these stakeholders have different perspectives on what is important to them. Parents may focus on the safety of the environment and ensuring that the institution meets the needs of their kids. Teachers, however, take in consideration the conditions of employment such as wages, benefits and work environment to measure the quality of the education (Layzer and Goodson, 2006). Whereas, students focus on the health and safety and ensuring that the concepts taught to them are accurate and up to date for the preparation of the real world.

A better quality education means a greater standard of living world-wide, as schooling helps children develop and acquire the skills, knowledge, and values necessary for the improvement in building stronger communities, economic prosperity, national productivity, and workforce participation (EFA Global Monitoring Report, 2005). Institutions can only achieve good quality schooling through the universal participation in education, which is fundamentally dependent upon whether attending school is worth the time and cost for the students and/or parent (EFA Global Monitoring Report, 2005). Some of the current methods that measures the overall quality of education received are years of completion, characteristics of the institution, scoring metric, curriculum, class size and teacher qualifications. These measures are explained in more detail below.

#### 5.2.3.1. Years of completion

The number of years or grades an individual has completed in formal institutions is a huge identifier of the quality of education received (Behrman and Stacey, 1997, Hanushek and Woessmann, 2010). Generally, the higher number of years completed results in a higher qualification. The average number of years spent in school is a common measure of a population's education level. It is a helpful measure because it demonstrates the education attainment across education levels. The increased appreciation of the benefits of education has also resulted in a rise in the average years of schooling that individuals attain and thus lower dropout rates. The number of years of schooling is practically useful as this quantitative aspect of education has become the main focus of attention in recent years, especially as it has become easily measurable.

#### 5.2.3.2. Characteristics of the institution

Another main method used to measure the quality of education is through the characteristics of an individual's school experience such as type of school, curriculum, class size and teacher qualifications (Behrman and Stacey, 1997). The type of school establishes the quality of education. Schools can be religious, sport-based, selective, public or private. Depending on the individual's priority, the specific needs of the quality will vary person to person. Selective schools, for instance, maintain their high standard by only allowing specific high grades or higher admission to their school. This in return produces a higher average result for the institution. On the other hand, some individuals prefer to have some form of cultural/religious upbringing and thus they undertake their learning through religious schools which classifies the quality of the school for this target audience. The option of public and private schools can also determine the quality of the institution and hence the education the students will receive. Public schools are funded by the government; however, private schools are not and thus are dependent on other forms of funding. Private schools are generally more expensive than public schools but may offer a better learning environment for the students. This can be achieved by ensuring a smaller number of attendees at the institution, resulting in a smaller class sizes and thus the teachers are able to put more focus on each individual need. Private schools generally also have better facilities for the students to use such as libraries, technology and sports grounds. Generally speaking, the school enrolment numbers

and attendance of the students attending classes are a good indicator of the quality of the school itself (Roser and Ortiz-Ospina, 2019a).

#### 5.2.3.3. Scoring Metric

Test scores or grades are commonly used as indicators to test the knowledge of individuals (Behrman and Stacey, 1997). A scoring rubric is often used in education as an attempt to communicate the expectations around a task assigned and to identify the individual's quality of work based on these expectations. Establishing a clear criteria makes the grading process fairer and more equitable. The purpose of a scoring metric is to describe how well students have performed according to the learning objectives for the course of study as grades generally reflect students' performance (Muñoz and Guskey, 2015). This ensures that students understand the various performance levels, and so they know exactly what the mark signifies and what must be done to improve the mark. Employers may look at the individual's grade as an indication of their performance, hence why having a proper scoring metric is essential.

#### 5.2.3.4. Curriculum

Another characteristic that can enhance the quality of education is the curriculum being taught. Ensuring that the basic building blocks for learning have been mastered is important. It is essential that the foundational skills have been taught so that students are able to grow and learn across a variety of different areas of the curriculum, especially as it progresses. A nationally consistent curriculum ensure that young people leave school with the skillsets that will support them to be successful further in their education, training or employment pathways they choose.

#### 5.2.3.5. Class size

Class size also impacts on the quality of education received. Research has shown that a larger class size depreciates the students' learning (Hattie, 2005). This is because the teacher is less able to meet the needs of each individual student. This thus means that some students fall behind in the education received and thus have difficulty further down the educational.

#### 5.2.3.6. Teacher Qualification

Teacher qualification is really important to the quality of education received by the students. Students need constructive feedback on the things that they are doing well and where further attention or improvement is required. The institution should ensure that the teachers hired have met the satisfactory requirements set by the government. This qualification should be universal as the quality of education the teachers receive will affect the quality of education received by the students. This cycle hence goes full circle and demonstrates the importance of the curriculum meeting a standardised quality.

#### 5.2.4. Challenges of Education

The world today is vastly different from what it was 50 years ago, or even the past decade. Especially over the last couple of years, the pace of change is accelerated due to the increase of globalisation. Globalisation is the process by which the world is interconnected with each other (National Geographic, 2019). Due to globalisation there has been a great advancement in technology, communications and social networking (Masters, 2015). On top of that there has also been a massive explosion of knowledge and thus an increase in access to information. This exponential growth of information, and the speed it is growing from, is a major challenge for Big Data. Due to this rapid growth, the world of work is undergoing rapid change with a much greater requirement for continual workplace learning (Masters, 2015).

Today, we live in a world in where time is fluid and everything changes constantly (Granado, 2018). The school curriculum should aim to attempt to equip students for this significantly changed and constantly changing world. An unwritten rule about education is that it is addressed as a preparation for life, and an essential element in progress and social change, in accordance with changing needs (Granado, 2018). However, this is lacking today as many features of the school curriculum have been unchanged for decades and the concepts being taught is not only out of date but is taught in isolation from the requirements of the workplace. This is quite concerning, considering that most tertiary graduates look for work straight after the completion of their degree. Recent studies demonstrate that only 71 per cent of graduates secure a job straight out of university, and approximately fifteen per cent of the graduates are unemployed even four years after graduating (Robinson,

2019). Today, schools are placing greater emphasis on factual and technical knowledge rather than the attainment of the skills required for the workforce today (Masters, 2015). As a result, experiences of students who undergo this curriculum can be very different from those of those who work in these disciplines, thus resulting in a depreciation of graduates within the workforce. This hence makes the process of employment difficult for graduates of today's generation.

Meeting these challenges requires a significant rethink of the school curriculum in order to avoid graduates and their employability rates falling further behind, to what it is today. The objectives of today's educational curriculum should focus on providing a greater priority to the skills and attributes required for life and work within the 21st century and ensuring that individuals are well-trained (Granado, 2018) by focusing on skills such as communication, use of technology, working in teams, problem solving, cross-disciplinary concepts, ability to apply these understandings to complex and engaging real-world problems (Masters, 2015). These are some of the essential skills of the workforce and by ensuring that the curriculum meets the following skills will change the shape of education. Graduates must ensure that they have the capacity to learn and willingness to face new things and modify learned expectations accordingly (Granado, 2018). Overall, this will give today's graduates a better preparation and opportunity to meet the expectations of the workforce. There are a lot of challenges associated with the current educational curriculum. Some of these challenges are described below.

#### 5.2.4.1. Identify students who are falling behind

It is important to identify students who are at risk of falling behind in their learning and to address their individual learning needs as early as possible (Masters, 2015). The issue with this is that some children are already well behind the expectations, and many of these children remain behind throughout their schooling, as there is no one identifying the struggles these students are going through. Others may fall behind due to being at risk of developmental delays or special learning needs. These students also need to be catered for in this modern world where equality amongst everyone is encouraged, including special needs students; thus the curriculum should aim to avoid exclusion of children with disabilities (Masters, 2015). International research has shown that students from

disadvantaged backgrounds are more likely to be low-performing, drop out of school and less likely to attain a better-paying job (Australian Government, 2016).

#### 5.2.4.2. Reduction of disparity between the schooling experiences of students

While educational disadvantage is a problem in almost all education systems across the globe, it is especially large in Australia. It is a reality faced by many Indigenous students, students who reside outside metropolitan areas, and/or students from low socioeconomic backgrounds (Perry, 2017). Australia has one of the largest resource gaps between advantaged and disadvantaged schools. These include a gap in the shortage of teachers, and having fewer educational materials (books, facilities, laboratories) (Perry, 2018). Educational disadvantage comprises access to (1) resources and facilities, (2) students' relationships and interactions with teachers and fellow students, (Perry, 2017, Perry, 2018) and (3) students' characteristics, skills and knowledge.

#### 5.2.4.3. Budget cuts

Budget cuts have created huge problems for most educational institutions in recent years. A reduction in funding means less staff, fewer resources and a lower number of services for students.

#### 5.2.4.4. Adaptation to the ongoing changes

An ongoing challenge that all educational institutions face is being able to identify and develop the knowledge, skills and attributes required for life and work in the 21st century. There are several reasons for questioning how well schools are currently equipping students for life beyond school described in Table 4 below:

<b>Current Curriculum</b>	<b>Description</b>
<b>Large amount of theory in curriculums</b>	Current curriculum is often dominated by a large amount of theory and technical knowledge, rather than the practical knowledge (Masters and Geoff, 2016). Australian students completed their compulsory study of mathematics and science with declining abilities to apply fundamental concepts and principles in real-world contexts (Masters and Geoff,



	2016). Society today requires adults who can engage in a perceptive way about a growing number of complex challenges (such as societal and environmental concerns).
<b>Subjects being taught in isolation</b>	Subjects at school and university tend to be taught in isolation from each other, which is especially concerning as there is an increased focus on working cross-disciplinary in today's world (Masters and Geoff, 2016). Workplaces are increasingly being structured around teamwork and looking for individuals who have good interpersonal and communication skills.
<b>Assessments focussing on rote learning</b>	School curricula often create assessments that focus more on rote learning rather than promoting creativity and the ability to develop innovative solutions to entirely new problems.
<b>Curriculum designed for traditional classroom settings</b>	School curricula tends to be designed for delivery in traditional classroom settings, at a time when new technologies are transforming how courses are delivered and learning takes place (Masters and Geoff, 2016). On top of this assessment processes provide information about subject achievement only, rather than information about students' abilities to work in teams, use technology, communicate, solve problems and learn on the job. New teaching and learning approaches to enable the development of critical and creative thinking should be integrated within the curriculum. The current educational curriculum focuses on rigid lecture and test models of learning. This results in students failing to challenge themselves and being able to adapt to changes.

*Table 4 - Current educational curriculum*

Adapting to the worldwide changes to avoid having the curriculum fall behind is extremely essential; the constant revision of curriculum based on the requirements of the current climate identifies new weakness and assists in the improvement.

## 5.3. Employability

Employability is about having the skills, ability and capability of gaining initial employment, and retaining jobs that benefit of themselves, their employer and the wider economy (Hillage and Pollard, 1998). There are a range of different definitions when it comes to employability and vary depending on the perspective of the stakeholder. For individuals, employability is the knowledge and skills used and presented to the employers (Hillage and Pollard, 1998). From the perspective of the employers, employability refer to 'work readiness'; that is, possession of the skills, knowledge, attitudes and understanding that will enable new graduates to make productive contributions to organisational objectives after commencing employment (Mason, Williams and Cranmer, 2009). However, despite the various definitions, it is important to know that employability varies according to economic conditions of a society (Brown, Hesketh and Wiliams, 2003). Employability cannot, therefore, be defined solely in terms of individual characteristics and is dependent on external factors as well.

### 5.3.1. Importance of Employment

Employability has become an important focus for graduates and employers in Australia, for the betterment of society. According to Yezdani (2017), full-time employment immediately following graduation was at 70.9 per cent in 2016 which demonstrates the correlation between employers and education. However, full-time graduate employment rates have varied significantly over the past 35 years, due to the changing conditions of employers and the increase in competition globally among graduates (Yezdani, 2017). Thus, it is important to focus on the needs of the employers within the current educational curriculum to increase the rate of employability for university graduates. Employment is beneficial for the individual, organisations and the community. Employment can impact a variety of factors such as economic conditions, individual's health, career development etc.

Economic development is an important factor when it comes to employability. Firstly, employment provides individuals with salaries and other benefits (such as annual leave, health benefits etc.) based on the quality of the work and culture of the organisation. This provides individuals with money to support themselves and allows them to explore their interests and pursue hobbies (Fit for Work team, 2015). In return this provides an increase

in economic growth due to part of the income being spent on a variety of goods and services (Vila, 2000). Due to this demand, a greater number of goods can be produced as well, which in return requires employability. Therefore, employment contributes to the economic growth as an increase in employment results in a greater number of goods to be produced as well (Capozzi, 2019)

Not only does employability assist individuals' organisations society financially, it also improves the quality of living standard as it helps improve business and/or productivity of any company. Today, employment is essential for the basic necessities such as food and shelter. However, due to the increase in living standards, the cost of living has also increased, and thus requiring individuals to earn more income. However, a fair and equal monetary benefit for individuals also results in reduction of the level of corruption within society as employed individuals are less likely to risk dangerous activities such as stealing and vandalism, especially if they feel a greater sense of community (TOOLKIT, 2004). The workplace holds great importance in society, as when workers enjoy spending time in the workplace, it reduces employee turnover in return. Furthermore, businesses enhance and utilise a worker's skill set when turnover is low (Capozzi, 2019).

Employability also improves an individual's wellbeing as they feel more productive and valued knowing that they are making important contribution to the society (Pennsylvania Department of Education). This in return increases individual's self-confidence and self-esteem allowing individuals to grow personally more. This allows them to develop new skills (both work and non-work related), such as communication, time management, team work skills, which can enhance the career of individuals and allow them to build a solid foundation to advance their own personal goals and their future overtime.

### 5.3.2. Education and Employability

There has also been a great concern in the research literature about the job–education mismatch; which means that there is lack of correspondence between the qualification level the job requires and the qualification level the employee has acquired through higher education. According to Yezdani (2017), 29.1 per cent of graduates feel that they are working in jobs that doesn't fully utilise their skills and education, and that the university curriculum does not prepare them for the real world. The aim of this research is to reduce this mismatch

and ensure graduates are work ready after the completion of their degree, by using big data within the review process (Støren and Aamodt, 2010). During this review process, employer involvement in course design will be vital, so that they can provide educators input in improving the curriculum to match the 21<sup>st</sup> century job market. The curriculum should aim at enhancing graduate's skillset in ways that should increase their attractiveness to potential employers (Mason, Williams and Cranmer, 2009).

### 5.3.3. Measuring employability

Measuring employability is not an easy task, especially due to the difference characteristics and requirements for each role in different companies. Employability can be dependent on several factors such as an individual's qualifications, the skills they already possess, and the need for the position in the organisation to be filled. An organisations reputation is also a significant factor which can influence an individual's decision to apply for the role. Key Performance Indicators (KPI) or employability performance indicators are methods to identify the effectiveness of the institution in developing employable graduates (Weligamage, 2009). Most of the time employability is measured by: (1) the ability of getting a job and (2) institutional effectiveness is usually indicated by the number of graduates who obtain employment over a specific period of time. However, to measure the effectiveness of individual and their qualification, the skills of the graduated individuals are then taken into consideration and hence institutional effectiveness might be indicated by a combination of factors such as (1) the opportunities of the institution, (2) graduates' satisfactions with their programme of study and (3) the extent to which the institution prepared the graduate for the world of work (Harvey, 2001, Tomlinson, 2008).

Whilst, these factors impact and shape an institutions effectiveness, there are also several factors during a graduate's study that impact and shape the individuals. These factors include: (1) the students' previous experience (e.g. previous work), (2) their extra-curricular activities, (3) career intentions and associated networks, and (4) the quality and availability of the employability experience within the institution (such as any work experience included within the program of study) (Greenbank, 2014, Harvey, 2001). Therefore, adapting external skills and some form of work experience within the degree will be valuable for the degree and the institution. The individual's qualification is only partially contingent on what is provided

by the institution, and a range of external factors are also considered today, such as work experience. It is for this specific reason that it is integral for university curriculum to adopt these skills and experience to prepare graduates for work-readiness.

The skills learned by students during their tertiary education can be classified as either technical or non-technical skills. Technical skills refer to content-specific knowledge and its relevant to, or within, a particular discipline. Whereas, non-technical skills are those skills which can be deemed relevant across many different jobs or professions (Greenbank, 2014). Employability Skills are not necessarily job specific, but are skills that are useful across all industries and across all different job roles (Cassidy, 2006). Employability skills and conceptions on how to make such skills more prominent within the tertiary educational curriculum have been a strong focus especially within the Australian higher education sector (Greenbank, 2014).

There are a range of different knowledge, skills and attitudes that employers are looking for. Today, graduate employability has become a key objective for government and a performance indicator for higher education institutions. Whilst employers may be satisfied in general with the level of technical skill of new graduates, they are not convinced by their competency in non-technical abilities or employability skills. Recent surveys demonstrate that graduate employers are more interested in personal attributes and soft skills than degree classification, subject or university attended (Archer and Davison, 2008). This is especially because, recently there has been an increase in the number of graduates, thus greater competition, which in return has changed employers' expectations. A university degree, which was once a bonus or differentiator, is now almost seen as a prerequisite for a job, even in sectors which in the past would not have needed a degree at entry level. Graduates are increasingly aware that they need additional skills and attributes for career success and education curriculum are now trying to adopt these soft skills within their degree programs. (Støren and Aamodt, 2010). These extra skills are now foreseen as a bonus on top of the degree. Employers generally look at a variety of skills such as: generic skills, occupational skills, career-management skills and personal attributes. On top of these measures, employers also consider the type of higher educational institution, mode of study, subject of study and previous work experience. More detail about these measures can be found in Appendix 2.

## 5.4. Literacy Frameworks

Today, the employment sector is becoming extremely competitive, and it is important that institutions (namely Universities) do not fall behind and keep up to date on what is taught in this competitive world. The adoption of Big Data in the review process of curriculum can assist in ensuring that institutions are kept up to date. It is essential that all education curriculum is continuously being reviewed, and suitable modifications are being made to adapt to the changes of the world. By reviewing the current education curriculum, it allows institutions to identify the gaps and weaknesses in-order to develop and improve educational curriculum for the future, rather than teaching outdated information that is no longer relevant. Today the full-time employability rate for those with undergraduate degrees in New South Wales (NSW) is around 73 per cent according to the 2018 Graduate Outcomes Survey, which is a decreased from as high as 85.2 per cent in 2008 (Singhal, 2019). This shows how competitive the current employability world is and the importance of why educational curriculum needs to be improved (Lin-Stephens et al., 2016). The educational curriculum needs to be able to adapt to the continuous changing nature of the job markets. Not using Big Data effectively within this review process can only result in graduates not being hired, as university may prescribe units that they deem valuable, however employers may not recognise that knowledge is useful anymore.

The abundance of career development theories indicates the complexity of career development and the challenges that reviewers face to ensure graduate work readiness through their educational curriculum. Career development learning was first introduced to the education sector in the 1970s and has progressed into more specific terms, models and theories. This paper will specifically focus on Lupton and Bruce (2010) information literacy learning model. The informational literacy learning model demonstrates a hierarchical relationship through the literacy levels, which are identified as Generic, Situated and Transformative (Lloyd and Talja, 2010, Lupton and Bruce, 2010). In this model, the generic level is the base level and concepts are also included within the Situated level, and thus situated level is also included in the Transformative level. Table 5 defines the information literacy learning framework in more detail.

<b>Literacy Level</b>	<b>Description</b>
<b>Generic</b>	Refers to cognitive skills and processes that provides individuals with the ability to find, analyse, and manage information (Lloyd and Talja, 2010). It is the basic skills needed in work and social life.
<b>Situated</b>	Includes skills and processes of the generic level, but also expands on it. The information in this level is evaluated and examined according to the context of individual and/or social group as the information could have different meanings in different context (Lloyd and Talja, 2010, Lupton and Bruce, 2010)
<b>Transformative</b>	Includes the skills of the generic level and the social practices and relevance of the Situated level. The skills in this level is seen through a range of information practices used to transform oneself and society, by challenging the norm (Lloyd and Talja, 2010)

*Table 5 - Information Literacy Learning Model*

This research has developed a matrix, by using this information literacy learning model (See Table 5). A range of current learning outcomes from a range of universities located in Sydney, Australia has been collected and categorised according to this information literacy learning model to better understand the current curriculum and better adapt for the future. This framework will further be developed using similar existing models such as the career information literacy framework (Lin-Stephens et al., 2016), and by gathering primary data, within future research. This data will be gathered from surveys which will be targeted at current undergraduate students, alumni from within a certain period and managers within the workforce. The aim is to identify the needs of the students, graduates and employers. A combination of these data will better assist in understanding the current educational curriculum and ways to improve them. A career-information matrix will be developed to demonstrate this further within future research. Hence, the combination of these methods within the educational curriculums can be provide a massive insight to better transform the educational curriculum in-order to meet the needs of the current job market, within the review process.

## 6. Methodology

The three main research methodologies that are to be used in this study are:

1. Qualitative research approach,
2. Hermeneutics methodology, and
3. Nickerson Taxonomy

The qualitative research approach is commonly used through-out any literature review by analysing a variety of academic and literature reviews relevant to the content, whereas the hermeneutics approach uses past experiences and activities of real-life organisation using the qualitative approach to gather information (Rennie, 2012). This research paper uses both of these research approaches. Relevant research papers are to be inputted into endnote, which is then labelled/categorised as “Big Data”, “Education” or “Employability” for better organisation. These research papers are then analysed, and the relevant information gathered based on the analysis is used within the literature review. The literature review in this research highlights the importance of Big Data within the Educational curriculum review process in order to meet the needs of the workforce today, which in return aims to increase employability. In order to understand the changes that need to be made to the educational curriculum, it is essential to identify the current weaknesses within the current educational curriculum and then strategising to enhance the future curriculum.

This research has assisted in the development of a matrix by using the information literacy learning model. This matrix has been developed using the Nickerson Taxonomy approach (Nickerson, Varshney and Muntermann, 2013). Nickerson Taxonomy explains the development process of creating matrixes within Information System (IS) by looking at characteristics of the objects being examined rather than looking at its evolution (Nickerson, Varshney and Muntermann, 2013). The purpose of developing a taxonomy within this research is to study the relationships between current educational curriculum and the skills that organisations are looking for. This is done by examining the learning outcomes from a range of units offered within IT degrees across a select number of universities based in Sydney.



The Nickerson taxonomy was implemented through the creation of the matrix found in Appendix 1, Table 2 and Figure 7. Each of the learning outcomes found in Appendix 1 was classified into three categories: Generic, Situated, or Transformative. Each of the applicable categories for that learning outcome was identified with a “Y” to represent “Yes”. This can be found in Appendix 1. Once each of the learning outcomes were categorised, each of the “Y” per subject were counted using the count function in Excel, in-order to calculate the overall number of Generic, Situated and Transformative skills per subject, which was then converted into a percentage out of 100. This was done for every unit in the sample study found in Appendix 1 and led to the creation of Table 2. Table 2, demonstrates the percentage of generic, situated or transformative skills that can be found within a subject. These subjects were then further classified into first year, second year or third year subjects to identify the level of study for the unit. Upon that classification the average percentage per Generic, Situated and Transformative per skill were calculated per year which lead to the graph in Figure 7. This breakdown into the number of years was important to identify the expectations of the level of difficulty and the type of skill that should be gained at the certain level. For example, in first year the students are expected to learn fundamentals, second year the framework should already be established and more advanced skills taught and in the final or third year of study, students are expected to think out of the box.

## 6.1 Progress and Future Research

Figure 1 demonstrates the current and future work of this research. The current work of this research includes the research progress conducted within the ten months of the Master of Research (MRES), year 2 program. The future work of this research will be conducted as part of the Doctor of Philosophy (PhD) program, within the next few years.

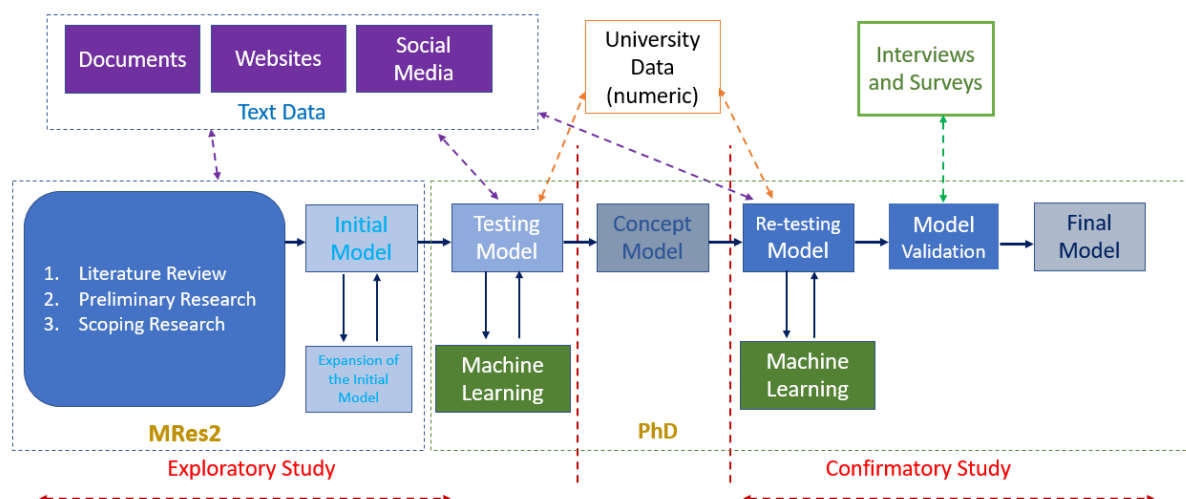


Figure 1 demonstrates that an exploratory (MRes2) study has been conducted in this research where a range of text data was used to assist in the development of the current literature review, preliminary research and to assist with scoping of the research. An initial model was created through the development of a matrix which can be found in Table 6. This initial model categorises a range of current learning outcomes from a range of different information technology units from universities based in Sydney, Australia based on the information literacy learning categories of generic, situated and transformative. The learning outcomes gathered for this matrix, was through the universities most up to date IT unit guides and categorised based on their each of their learning outcomes (Appendix 1). This provided the analysis of the skills taught at a university level as the data was then converted into a matrix and then further converted to a visual representation for better comparison. This creates a new level of understanding of the current curriculum and to assists in the adaption of an improved curriculum for the future. This is demonstrated through the 'initial model' stage in Figure 1.

The information literacy learning framework will further be developed within future work of this research, by using similar existing models such as the career information literacy framework (Lin-Stephens et al., 2016), by gathering primary data. This research will require human ethics approvals as we intend to interview a vast variety of people and thus must ensure that the correct regulations and approval process will follow (Approval has been granted).

Once the exploratory study framework has been tested, a confirmatory study would be conducted by using university data and a range of interviews and surveys. We intend to interview alumni who have recently graduated (within the last 5 years), current tertiary students, academics, lecturers/professor and senior managers currently working in organisations that are responsible for recruitment. Once the primary and secondary data is conducted a comparison between the research and the interview will be made and will be included as part of the results in-order to create an improved matrix. This aims to a grasp a better understanding on the overall topic to make any effective decisions on the educational curriculum by identifying the needs of the students, graduates and employers. A combination of these will better assist in understanding the current educational curriculum and ways to

improve them. Thus, there are two stages for the project: (1) Development of the current educational framework and (2) Development of a workable educational curriculum based on the matrix. Hence, the combination of these methods within the educational curriculums can be provide an extensive insight to better transform the educational curriculum in-order to meet the needs of the current job market, within the review process. Figure one visually demonstrates the research methodology of both the (1) exploratory study which was mainly conducted in this report and the (2) confirmatory study which is the future work of this research.

## 7. Results

A range of current learning outcomes from a variety of different universities located within Sydney in Australia have been collected and categorised into a matrix table according to the information literacy learning framework to understand the current curriculum and to better adapt it in future (Table 6). They have been categorised as Generic, Situated and Transformative Learning, based on the information literacy learning framework (See Table 5 above for more detail). The learning outcomes are collected from units or subjects within information technology degrees, ranging from first year to third year level units across four Sydney universities. These learning outcomes can be found in more detail in appendix 1 for each of the units examined in Table 6. The universities included in this study of research include Macquarie University, University of Technology (UTS), University of New South Wales (UNSW), and Western Sydney University (WSU). The IT degree across all four of these universities is a maximum of a three-year full-time bachelor program but have a range of different majors offered.

The results demonstrated in Table 6 below, are a selection of sample units that have been examined and were taken from units offered within the Bachelor of Information Technology program across these four universities. It demonstrates the percentage of skills demonstrated at a generic, situated and transformative level.

University	Year	Unit Name	Generic	Situated	Transformative
Macquarie University	1st	Introduction to Computer Programming	100%	0%	0%
		Fundamentals of Computer Science	40%	60%	0%
		Introduction to Business Information Systems	100%	0%	0%
		Introduction to Systems Design and Data Management	50%	50%	0%
	2nd	Object-Oriented Programming Practices	66.7%	33.3%	0%
		Data Communications	0%	66.7%	33.3%
		Database Systems	25%	25%	50%
		Applications Modelling and Development	0%	100%	0%
	3rd	Programming Languages	50%	50%	0%

		Big Data	0%	50%	50%
		Enterprise Systems Integration	20%	60%	20%
		Business Information Systems Project	0%	40%	60%
<b>UTS</b>	1st	Introduction to Information Systems	0%	80%	20%
		Programming Fundamentals	100%	0%	0%
	2nd	Network Fundamentals	33.3%	66.7%	0%
		Information System Development Methodologies	25%	25%	50%
	3rd	Industry Experience 2	0%	0%	100%
		Project Management and the Professional	20%	80%	0%
<b>UNSW</b>	1st	Introduction to Business Databases	62.5%	37.5%	0%
		Fundamentals of Business Programming	33.3%	66.7%	0%
	2nd	Intermediate Business Programming	16.7%	33.3%	16.7%
		Database Management & Big Data Infrastructures	0%	66.7%	33.3%
	3rd	Business Process Management	0%	100%	0%
		Networking & Cyber Security	0%	75%	25%
<b>WSU</b>	1st	Programming Fundamentals	20%	40%	40%
		Database Design and Development	100%	0%	0%
	2nd	Computer Networks and Internets	64.3%	28.6%	0%
		Web Systems Development	0%	100%	0%
	3rd	Human-Computer Interaction	14.3%	28.6%	57.1%
		Professional Experience	0%	25%	75%

Table 6 - Information System Units Matrix based on the Information Literacy Learning Model

The table above (Table 6), has been transformed into a range of different visual graphs (Figure 2, 3, 4, and 5), to demonstrate a better comparison of the data collected from the learning outcomes at generic, situated and transformative levels. The below graphs are split based on universities (that is Macquarie University, UTS, UNSW and WSU) to better visualise and analyse the similarities and differences within the learning outcomes of the same degree within a state.

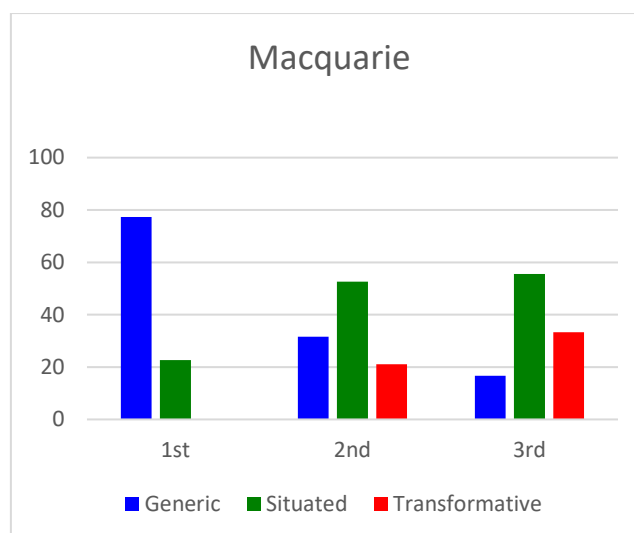


Figure 2 - Current Educational Curriculum after gathering unit guides from Information Technology Units at Macquarie

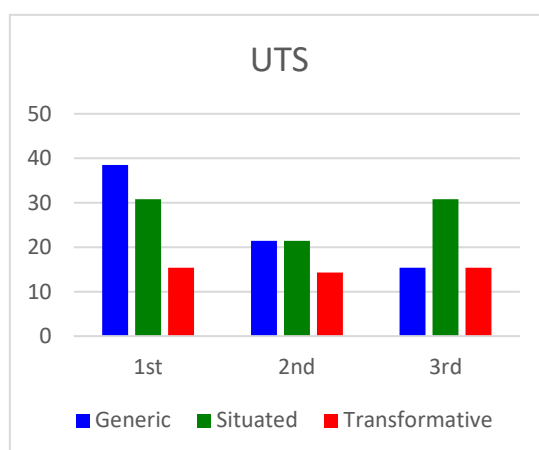


Figure 3 - Current Educational Curriculum after gathering unit guides from Information Technology Units at UTS

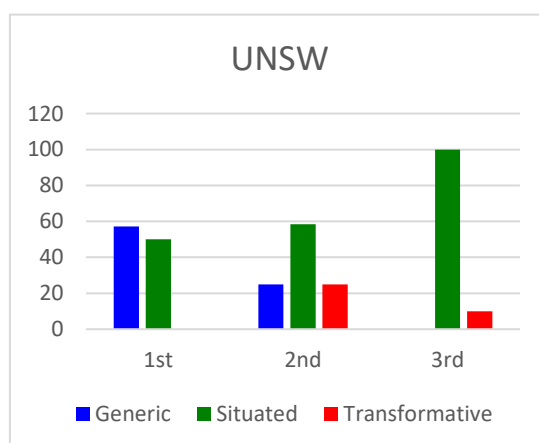


Figure 4 - Current Educational Curriculum after gathering unit guides from Information Technology Units at UNSW

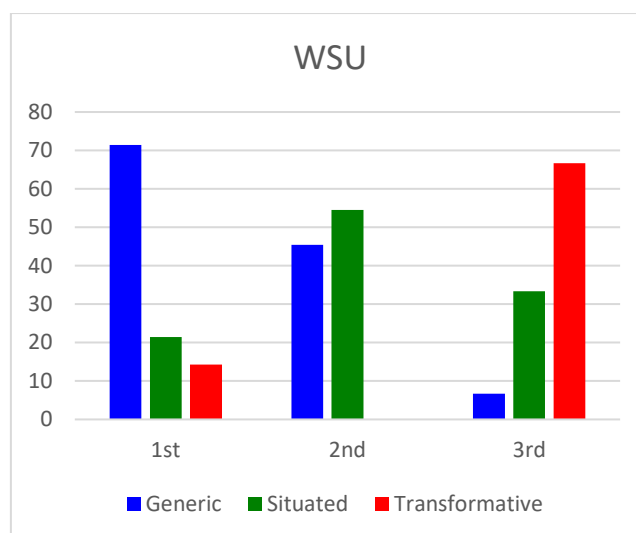


Figure 5 - Current Educational Curriculum after gathering unit guides from Information Technology Units at WSU

Based on the matrix shown in Table 6, and the information literacy framework, a comparison graph between the hypothesis (Figure 6), the current educational curriculum based on the results gathered from Table 6 (Figure 7) and the future proposed educational curriculum (Figure 8) can also be drawn. These figures demonstrate the development and progression of the educational programs throughout the degree.

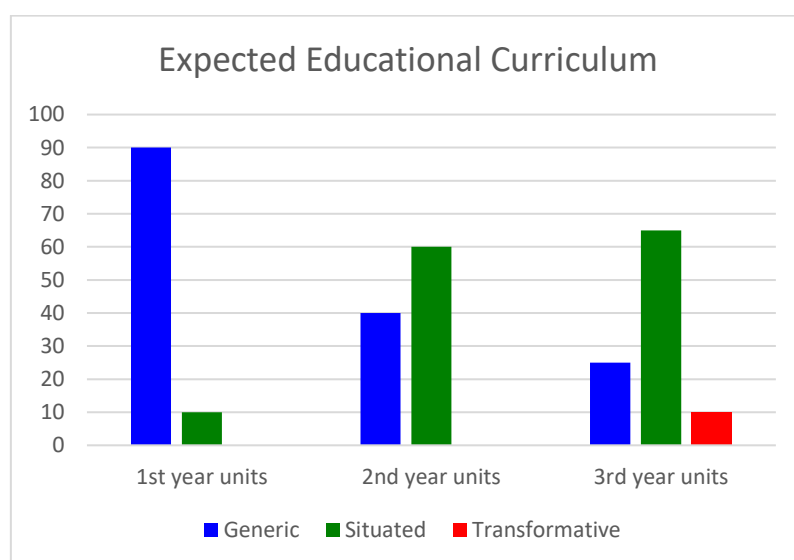


Figure 6 - Expected Educational Curriculum prior to conducting any research (Hypothesis)

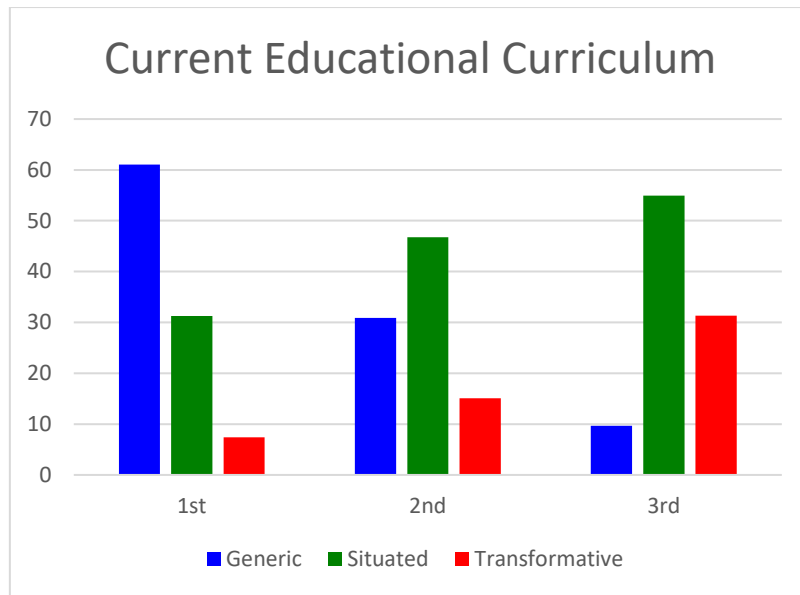


Figure 7 - Current Educational Curriculum after gathering unit guides from Information Technology Units (Based on Table 6)

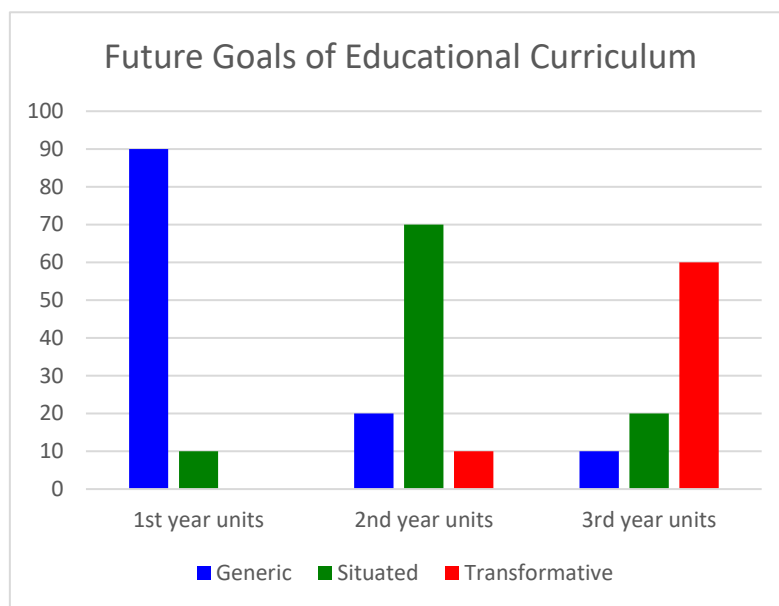


Figure 8 - Future direction of what the Educational Curriculum should look like (Future Research)

As shown in Figure 7, there is a lack of transformative skills currently (although higher than expected as shown in Figure 6) and the proposed educational programs will aim to encourage transformative learning to better equip graduates within the workforce. The new proposed matrix will aim for this transformation and will be future work of this research.



## 8. Discussion

As demonstrated in the table and figures above (Table 6, Figure 7, 8 and 9), it is evident that there is a progression in the informational literacy learning model across the study areas from generic, to a situated and transformative style of learning. Figure 6 demonstrates the hypothesised framework of educational curriculum which hypothesises that first-year units will focus heavily on generic skills, second year units will focus on both generic and situated skills and final year undergraduate units will focus more on situated skills with minimal focus on transformative skills. However, after collating unit guides from a small sample of units and categorising the unit outcomes according to the matrix (Table 6 and Figure 7), it was evident that the university's educational curriculum progresses through these three stages, but heavily focuses more on situated learning as hypothesised. Currently the third-year units (Figure 7), focus on situated learning more than transformative, and should actually in the future aim to be higher in-order to better equip the students. The breakdown of these analysis is demonstrated in detail through Table 6, Figure 2, 3, 4, and 5. They demonstrate the analysis of the information literacy learning framework per university.

### 8.1. Macquarie University

Macquarie University is a public research institution located in Sydney, Australia. The university itself have grown a lot since its establishment in 1964, with approximately 40,109 students, 3,199 staff and 164,000 alumni (Macquarie University, 2017). It is evident through Figure 2, that Macquarie University has a range of generic, situated and transformative skills available throughout their IT degrees. For the sample of units examined, it is evident that Macquarie University focuses on generic learning heavily within first year units and are also taught about briefly across second and third years. The universities main focus has been on situated learning specifically across second and third-year units. There are also elements of transformative learning being taught briefly across the second and third year. The amount of transformative learning units is much higher than hypothesised (Figure 6) in the third year, and this is specifically due to the compulsory Macquarie University's PACE unit, Business information system project, which focus on providing industry experience to the students during their final semester at university. The aim of this program is to prepare students for the real world, by providing them opportunities outside the classroom environment, and for

them to think critically outside of the classroom. Depending on the discipline, the practicum appears in many forms: as field or clinical placement, internship, clerkship etc. (Ryan, Toohey and Hughes, 1996). This PACE unit at Macquarie University boosts up the transformative level as shown in Figure 2.

## 8.2. University of Technology Sydney

The University of Technology Sydney (UTS) is a public research university located in Sydney, Australia and has around 44,000 students currently and was established in 1988 (UTS, 2019). UTS has a range of learning approaches that have been implemented throughout the first, second year and third year units as demonstrated through Figure 3. Unlike, other universities, transformative learning has been taught from first year at UTS. However, despite this learning approach being taught, the generic and situated learning are still taught at an equivalent or higher rate throughout the IT degree. All years at UTS have some elements of generic, situated and transformative learning approaches. However, situated learning is again the main learning approach taught at UTS as well.

## 8.3. University of New South Wales

University of New South Wales (UNSW) was established in 1949 and is located in Sydney, Australia. The university has around more than 59,000 students and a 7,000-strong research community (UNSW, 2019). Figure 4 demonstrates the literacy frameworks of UNSW IT degree units. As demonstrated by the graph, it is evident that the university heavily focuses on situated learning across first, second and third-year units. As with the universities mentioned above, the first-year units focus on generic learning skills the most. On top of this, UNSW does not focus a lot on transformative learning especially in the final year units. In fact, from the sample examined it is visible that transformative learning approaches are taught more in second year units than the final year by a small percentage. Figure 4 demonstrates that there is a large focus on situated learning at UNSW compared to the other learning approaches throughout the degree.

## 8.4. Western Sydney University

Western Sydney University, formerly the University of Western Sydney, is an Australian multi-campus university located in Sydney, Australia (Western Sydney, 2019). The university was founded in 1989 WSUs current education curriculums learning approaches is

demonstrated through Figure 5. This university has the closest potential to the proposed future learning approaches as demonstrated in Figure 8 so far. WSU heavily focuses on generic skills within their first-year units with elements of situated and transformative approaches. The second-year units heavily focus more on situated learning whilst also having a heavy focus on generic. The third year heavily focuses on transformative approaches of learning with strong situated learning and minimal generic learning. This is specifically due to both the units examined in final year having a 50% focus on transformative learning approaches each. This progression through the stages allows individuals to build on the skills slowly year to year and is the most ideal progression to match the skills of employability.

After gathering all these units, Figure 7 collates the data from all universities and provides an overall average view of the current university curriculum by specifically examining IT degrees. As evident through the graph, all universities focus heavily on generic learning skills within their first-year units, with some elements of situated and minimal on transformative. This is to provide first years with the theory and the basics required for progression within the degree. The second year focuses heavily on situated with some elements of generic but again a low level of transformative learning approaches. However, this transformative learning approach is taught more than in first year. This demonstrates the progression of the university curriculum and providing students the opportunity to critically think. The final and third year of the IT program focuses mostly on situated learning, with elements of transformative learning in-order to challenge the students. In this final stage, students are expected to have a general concept of the content being taught, which is why there is very minimal generic level of study being taught. This current educational curriculum is on the right track of progression to meet the demands of the 21<sup>st</sup> century. However, it does require more transformative skills to be taught, specifically in the final year to ensure that graduates are work-ready after the completion of their degree. The new proposed matrix will aim for this transformation and will be future work of this research. The future research will also aim to look at a more diverse range of units and universities across Sydney, Australia.

## 9. Conclusion

The significance of this research relies on creating a contribution to knowledge and a deeper understanding of Big Data and its affects to an organisation at the end by the process of identifying and gathering relevant data in-order improve organisations efficiency by making more informed decisions. The key value of Big Data is in the decision-making process which determines the past trends and use these for future planning. However, challenges of the petabyte age of digital data is faced which can be demonstrated through the Vs of Big Data: Volume, Variety, Veracity, Velocity and Value. Due to these challenges, coming up with a standardised tertiary curriculum worldwide is difficult. Education is important as not only does it teach individuals the life skills needed to survive today, but also to make better judgement and maintain a healthy economic wellbeing globally. Every employer is looking at an individual's education as well as determining the life skills that they have developed along the way. Employers and organisations are looking at students who have excelled beyond the university curriculum and can demonstrate the ability apply the knowledge learnt successfully within the practical life (Singhal, 2019). The research will look at ways to improve the current university curriculum to match the skills that employees are looking for and ensure that institutions and keep up to date with what is taught. This will be established through the information literature learning framework and using it as a matrix to identify the current trends of educational program and propose a future framework for the educational program. Thus, the adoption of Big Data in the review process of curriculum can assist in identifying the currents flaws and ensure that they are improved so that institutions are kept up to date and thus in correlation assist with the country's economic wellbeing.

The future work of this research will aim at further developing this information literature framework and expanding the current matrix to gain a better image of the requirements of the workforce. A range of interview and surveys will be conducted to gather information from current student, alumni, lecturers and employers to gain a better understanding and to test the new and improved model. Finally, the PhD thesis will look more closely towards data analytics and will be renamed to: "How Data Analytics Can Influence Tertiary Education Curriculum to Increase Employability", as it better re-aligns with the domain of the future work of this research.

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## Appendix

University	Year	Unit	Unit Name	Learning Outcomes	G	S	T
Macquarie University	1st	COMP115	Introduction to Computer Programming	Describe the main components of a computer system and the role that different kinds of programming language play in computer software development	Y		
				Apply problem solving skills to develop algorithms that solve small to medium-sized computational problems	Y		
				Design and code implementations of their algorithms in an imperative programming language	Y		
				Use standard software engineering practices to document, debug and test their programs	Y		
				Identify and describe ethical issues that arise in the application of information technology	Y		
				Demonstrate foundational learning skills particular to computer programming including active engagement in their learning process.	Y		
Macquarie University	1st	COMP125	Fundamentals of Computer Science	Apply enhanced problem-solving skills to develop algorithms	Y		
				Implement programs (from algorithms), showing an understanding of the underlying architecture of the computer		Y	
				Adhere to standard software engineering practices (in particular documentation using Javadoc, testing using JUnit framework and debugging using Eclipse debugger)		Y	
				Compare different methods available for the same problem in terms of efficiency and other criteria		Y	
				Demonstrate foundational learning skills including active engagement in their learning process General Assessment I	Y		
Macquarie University	1st	ISYS104	Introduction to Business Information Systems	To develop an introductory understanding of a range of important and/or current IT issues	y		
				To understand the core principles and components of the Information Systems discipline	y		
				To recognise how information systems can be used to improve business performance	y		
				To demonstrate a competence with basic information technology applications, including basic computer management, e-mail, web browsers, web-page creators and productivity software	y		
				To develop an understanding of how such applications work, to a level where students can learn new material without requiring formal training	y		
				To gain introductory skills with an exposure to a 4th-generation programming environment	y		

				To demonstrate foundational learning skills including active engagement in their learning process	y		
Macquarie University	1st	ISYS114	Introduction to Systems Design and Data Management	Analyse data requirements and design and develop conceptual database models.		y	
				Implement system models into databases, design and create simple databases for business information systems and write programs to produce interactive queries.			y
				Use data analysis and data modelling techniques and tools for introductory level database design and specification	y		
				Explain the role and nature of ethics and sustainability in the IT environment related to databases	y		
Macquarie University	2nd	COMP229	Object-Oriented Programming Practices	Understand the key concepts of object-oriented programming, and program proficiently in an OO programming language	Y		
				Have an ability to use application libraries, in this case the Java SE API	Y		
				Be familiar with and apply good programming practices such as testing, debugging, documentation, version control, programming tools and interactive development environments (IDE)	Y		
				Understand the concepts underlying design patterns and apply a working knowledge of a selection of well-known design patterns (singleton, observer, factory, iterator, facade, decorator etc)	Y		
				Apply key OO concepts and libraries to design and develop graphical applications		Y	
				Apply key OO concepts of concurrency in working code.		Y	
Macquarie University	2nd	COMP247	Data Communications	Enunciate the importance and the role of network protocols including why they are organised into protocol stacks and how protocol stacks function.		Y	
				Demonstrate an understanding of IP addressing, routing and subnetting by for example computing routing outcomes and determining effective and actual IP addresses.			Y
				Differentiate among LAN components, and describe and, in particular instances calculate, how MAC addresses, address resolution (as implemented by protocols such as ARP) and the ethernet protocol interact.		Y	
				Be aware of different major network technologies including wireless, backbone, wide area networks, and the Internet and, being aware of their properties, be able to evaluate different network designs.		Y	

				Demonstrate technical networking proficiency including demonstrated ability to configure, construct, and document, and in simple cases, design networks, as well as the ability to perform traffic analysis on local area networks.		Y	
				Be acutely aware of issues in and have an ability to develop plans for dealing with, network security and management.			Y
Macquarie University	2nd	ISYS224	Database Systems	Demonstrate understanding of the basic concepts that underlie modern database management systems.	Y		
				Design and develop small, functional database applications using modern database design methods.		Y	
				Develop skills in using an industrial-strength database tools and interactive development environments for building databases.			Y
				Complete different database programming tasks to specification using SQL.			Y
Macquarie University	2nd	ISYS254	Applications Modelling and Development	Demonstrate ability to communicate software requirements and designs, clearly and effectively.		Y	
				Practice the key phases of the software development life cycle (SDLC) including requirements engineering, analysis, design, basic development and testing and demonstrate understanding of alternative SDLC lifecycle models.		Y	
				Demonstrate an understanding of the concepts and tools needed to successfully design and build a mobile application with a database-centric approach		Y	
Macquarie University	3rd	COMP332	Programming Languages	Explain the role that languages play in software development and describe a spectrum of software languages that are in current use.	Y		
				Express properties of software languages using formal notations.	Y		
				Translate formal notations of software language properties into implementations of language processors.		Y	
				Demonstrate that a language processor is operating correctly by construction and use of appropriate test cases.		Y	
Macquarie University	3rd	COMP336	Big Data	Explain the key Big Data concepts and techniques.			Y
				Apply Map-reduce techniques to a number of problems that involve Big Data.		Y	
				Apply Big Data techniques to data mining.			Y
				Apply techniques for storing large volumes of data.		Y	
Macquarie University	3rd	ISYS301		Ability to acquire knowledge needed to integrate new systems and processes of an organisation	Y		

			Enterprise Systems Integration	Competence in IT strategic planning.			Y
				Ability to use various modelling techniques to describe information flows and processes in an organisation.		Y	
				Competence in XML (eXtensible Markup Language) to web enable business applications.		Y	
				Competence in Web Services Description Language (WSDL) and Business Process Execution Language (BPEL).		Y	
Macquarie University	3rd	ISYS358	Business Information Systems Project	Critically analyse, describe and apply principles and models of software development and how they fit within the larger context of systems engineering			y
				Understand and perform the stages of the software development life cycle (requirements analysis, design, construction, testing) and its different process models in an authentic context		y	
				Understand and make use of the basic principles of project management, teamwork, the roles and responsibilities of the project manager and appreciate the importance of working closely with the project's customer and the delivered system's end-user(s)			Y
				Effectively Communicate results of the software development process (in both written and oral form)		Y	
				Recognise and address ethical issues when they arise based on an understanding of professional ethics			Y
UTS	1st	31266	Introduction to Information Systems	Analyse the business, organizational and society environment, proposes effective types of IS for obtaining and maintaining competitive advantage.			Y
				Describe data and knowledge management approaches.		Y	
				Describe different system development methodologies.		Y	
				Identify ethical issues in the IS context and propose recommendations.		Y	
				Analyse end user experience.		Y	
UTS	1st	48023	Programming Fundamentals	Demonstrate a working knowledge of the basic constructs in the object-oriented language Java by being able to complete small programs.	Y		
				Use the BlueJ programming environment to build simple software systems.	Y		
				Design and code a software system that correctly implements a solution to a small problem defined by a specification and follows specific design rules.	Y		
				Comprehend and use basic program control constructs of sequence, selection and iteration.	Y		
				Comprehend and use code that implements arrays and the basic sorting and searching algorithms.	Y		



UTS	2nd	41092	Network Fundamentals	Understand the key architectural principles of the Internet, namely protocol layering and service models.	Y		
				Analyse various components of the Internet, including Applications, Transport, Network, Addressing, and Data Link, to select the most appropriate network services.		Y	
				Examine and explain end-to-end packet delivery throughout the network system to gain insight into the behaviour of the Internet.		Y	
UTS	2nd	31257	Information System Development Methodologies	Analyse key aspects of a number of Information System development methodologies to develop business Systems.			Y
				Explain that different methodologies target different aspects of Information System development, such as requirements gathering, project management or cross-organisational development.		Y	
				Evaluate development methodologies and articulate their underlying philosophies to solve organisational Information System problems.			Y
				Illustrate a methodology, or aspects of different methodologies to substantiate the suitability of particular circumstances.	Y		
UTS	3rd	41016	Industry Experience 2	Advance and apply theoretical knowledge and skills in the workplace.			Y
				Enhance theoretical knowledge and skills through reflection on workplace learning and experiences.			Y
UTS	3rd	31272	Project Management and the Professional	Identify alternative models for the management of projects and how these can be applied in practice;		Y	
				Explain the requirements and structure of information systems project management within business environments		Y	
				Explain the nature of project success and the need for assuring quality outcomes		Y	
				Explain the social impact of information technology, responsibility of IT professionals and importance of ethical codes of conduct;		Y	
				Synthesize, evaluate and order team member contributions while working in groups to build deadline-driven project deliverables.	Y		
UNSW	1st	INFS1603	Introduction to Business Databases	Discuss the relation between database and IS development processes.		Y	
				Apply conceptual database modelling methods (e.g., ER modelling).		Y	
				Apply normalisation techniques to database schema.		Y	
				Create small-scale database system (e.g., in Oracle).	Y		
				Apply queries languages to access and update databases.	Y		

				Prepare and present technical reports.	Y		
				Carry out professional teamwork.	Y		
				Discuss professional responsibilities and ethical issues regarding databases.	Y		
UNSW	1st	INFS1609	Fundamentals of Business Programming	Develop ability to interpret and write reliable, well-structured, and well-documented software programs		Y	
				Describe and apply the principles of object-oriented programming in developing software programs		Y	
				Demonstrate ability to effectively use an Integrated Development Environment for software development		Y	
				Develop problem-solving skills in designing and implementing programming solutions		Y	
				Examine and debug basic software programs	Y		
				Comprehend and apply software testing methods	Y		
UNSW	2nd	INFS2605	Intermediate Business Programming	Interpret, review and share software code.			Y
				Design, write and evaluate programming solutions for small to medium scale problems.		Y	
				Explain and apply MVC architecture in developing programming solutions.	Y		
				Design, write and evaluate GUI programs that interface with relational databases		Y	
				Design, write and evaluate programs that use APIs.		Y	
				Apply UX methods/techniques in the development of software.	Y		
UNSW	2nd	INFS2608	Database Management & Big Data Infrastructures	Investigate emerging technologies and recent trends in database design and Big Data.			Y
				Apply the basic principles of database design.		Y	
				Evaluate and discuss Big Data analytics strategies.			Y
				Prepare written documentation at a professional standard.		Y	
				Present oral presentations at a professional standard (including technical content).		Y	
				Work in a team solving complex data-related problems.		Y	
UNSW	3rd	INFS3604	Business Process Management	Synthesise the principles of organisational strategy and process design.		Y	
				Explain the role of Information Technology and other resources in BPM.		Y	
				Document processes using a process mapping tool complying with Business Process Management Notation.		Y	
				Analyse the performance of existing processes and identify process improvement opportunities/strategies.		Y	

				Propose business solutions in written and verbal forms for process innovation and redesign Projects.		Y	
				Create a BPM implementation strategy and implementation plan for an organization.		Y	
UNSW	3rd	INFS3617	Networking & Cyber Security	Describe principles and policies of networking and cyber-security		Y	
				Develop skills to analyse issues associated with business data networks and network security and to develop practical solutions towards their resolution			Y
				Demonstrate ability to evaluate relevant technical and ethical considerations related to the design and deployment of secure networks within various business contexts		Y	
				Demonstrate ability to effectively communicate principles and policies of networking and cyber-security, and explain their applications in various business contexts		Y	
WSU	1st	300580	Programming Fundamentals	With a chosen programming language in mind, analyse a given problem and from a simple problem description, identify desired inputs, outputs, and the necessary processing operations to convert input into output;			Y
				Develop an algorithm that applies structured programming techniques that solve the given problem;			Y
				Choose suitable data types to store relevant data for the given problem;	Y		
				Design and code programs which use standard programming concepts: variables, sequence, loops, decision making constructs, mathematical and boolean operators, as well as functions;		Y	
				Apply top-down modular design principles to programming problems and implement the solution using the chosen programming language.		Y	
WSU	1st	300104	Database Design and Development	Describe components of a database system, advantages and disadvantages of a database system, roles peoples play and the historical development of a database system in the context of a Relational Database Management System (RDBMS).	Y		
				Apply basic skills in database modelling, including ER diagrams and normalization in RDBMS.	Y		
				Explain the basic concepts of relational algebra and apply them in queries.	Y		
				Describe the general concepts of transaction management.	Y		
				Identify concepts in database administration.	Y		
				Describe concepts in database security and backup.	Y		
				Define and manipulate data using structured query language (SQL)	Y		
				Design and develop a database for a business application using a commercial database management system	Y		

				Investigate and apply advanced database techniques such as higher normal forms, stored procedures, triggers, indexes and limited data denormalization	Y		
WSU	2nd	300095	Computer Networks and Internets	Design the physical layout of the network and produce a specification diagram	Y		
				Provide detailed network documentation in the appropriate format		Y	
				Design an Internet Protocol (IP) subnetting scheme using Variable Length Subnet Mask (VLSM) & Classless Inter-Domain Routing (CIDR)		Y	
				Design and propose appropriate router and switch configurations		Y	
				Verify and troubleshoot various types of network connections		Y	
				Provide a written final report/network design proposal to a professional standard	Y		
				Correctly configure a Wireless Local Area Network (WLAN)	Y		
				Correctly configure single-area Open Shortest Path First (OSPF) protocol	Y		
				Correctly configure Virtual Local Area Networks (VLANs) and 802.1q trunking	Y		
				Correctly configure Frame Relay	Y		
				Correctly configure Dynamic Host Configuration Protocol (DHCP)	Y		
				Correctly configure Network Address Translation (NAT)			
				Create and apply Access Control Lists (ACLs)	Y		
				Create a Hierarchical Network Design	Y		
WSU	2nd	300583	Web Systems Development	Apply CSS framework to lay out and style website		Y	
				Apply LINQ to construct database queries		Y	
				Apply Entity Framework Core to bind objects with database records		Y	
				Implement both client-side and server-side data validation		Y	
				Implement dynamic webpages with Razor syntax		Y	
				Apply MVC framework to develop web systems		Y	
				Implement user authentication and authorization for web systems		Y	
				Apply collaborative skills to work in a team in developing complex web systems		Y	
WSU	3rd	300570	Human-Computer Interaction	Apply cognitive models to the design of application user interfaces.		Y	
				Indicate ways in which users' characteristics (i.e., age, education, cultural differences, disability etc.) require adaptation of a user interface to increase effectiveness.	Y		
				Integrate appropriate user-centred design methodologies into the development of an application or website and recognise advantages and disadvantages of doing so.e.			Y

				Describe major usability guidelines and standards, for e.g. ISO or Nielsen		Y	
				Develop both low-fidelity and high-fidelity prototypes and produce user interfaces for domain specific applications.			Y
				Create an appropriate user evaluation plan with carefully chosen subjective and objective measures.			Y
				Discuss state of the art research issues and novel interaction technologies under the umbrella of HCI.			Y
WSU	3rd	300579	Professional Experience	Successfully complete all tasks from Requirements Analysis to Implementation of SDLC in producing a software product or a component of a software product as needed by the client			Y
				Produce a full set of professional level documents as needed by the project covering all phases of the SDLC		Y	
				Integrate skills and knowledge gained from multiple units the student has undertaken in their course to date and also put together knowledge from many and varied sources as required by the project.			Y
				Discover, investigate and self-learn technologies needed for completion of project activities			Y
				Develop skills in foreseeing or predicting probable risks; and plan, organise and control project activities to mitigate such risks			Y
				Duly, responsibly and independently complete the assigned tasks, under various constraints and pressure			Y
				Reflect back on the learning experience and identify own professional maturity to approach software development problems with a wide understanding of the issues involved and managing software development projects			Y
				Present and demonstrate the developed system to a panel of professionals, stakeholders and other interested parties		Y	

Appendix 1 - University Units and their Unit Outcomes

<b>Measuring Employability</b>	<b>Description</b>
<b>Generic Skills</b>	Generic skills refer to the basic skills including, but not limited to: communication, team building/team work, problem solving, decision making etc. (Cassidy, 2006, Hillage and Pollard, 1998).
<b>Personal Attributes</b>	Personal Attributes refer to personality traits such as: reliability, integrity, dependability, responsibility, positive skills, co-operation, self-discipline, self-motivation etc. (Cassidy, 2006, Hillage and Pollard, 1998).
<b>Occupational Specific Attributes</b>	Occupational specific skills vary and depends on the role and nature of the company. They are the technical skills learned throughout their academic career or duration of their degree, and varies in nature and complexity from discipline to discipline (Hillage and Pollard, 1998). However, as indicated above, the professional industry is looking for graduates who come equipped with the skills to be begin their employment confidently, in other words, graduates who have a set of skills that define them as work-ready (Gill, 2018). This work-ready approach supports the notion of teaching that limits its practice to the intellectual level of academic competence and favours the practical and operational competence of the work environment (Gill, 2018). Employers' recruitment procedures vary from organisation to organisation based on the role, culture of the company and the number of applications received. It is essential to note that there is a range of factors that influence the employment process, irrespective of the opportunities afforded learners in their undergraduate programme of study. They include: (1) Type of Higher Education Institution (2) Mode of Study (3) Subject of Study (4) Previous Work Experience and (5) Age, Ethnicity, Gender or Social Class (Gill, 2018).
<b>Type of Higher education institution</b>	<p>Every institution is ranked to determine its success nationally and internationally. These ratings could be based on several factors such as research, job employability rates, degree/courses offered. An institution's ranking may influence on the graduate employability rates. However, ranking is not everything as some institutions have good graduate employment rates because of their reputation which may have more to do with employers' perceptions that the 'best' students go to the institution rather than perceptions about how prepared the students are for work readiness by the institution (Harvey, 2001).</p> <p>The accessibility and access to higher education has increased demand for information on academic quality and has led to the development of university ranking systems across many countries of the world. Due to the importance of education, variety and range of different institutions available, as well as the expensive cost of tertiary education, students are seeking information that will help them make informed choices in the selection of a university and/or an academic program of their field of study. Academic quality/ranking is often an influence in choosing institutions as this will result in a greater quality of education but also a higher employability rate for graduates (Dill and Soo, 2005, Taylor and Braddock, 2007, University of Sydney, 2016). Recent surveys suggests that students' in the UK (Connor, 1999) consider that the most important factors influencing the choices of applicants to full-time university education are: (1) course or subject, (2) academic quality (particularly teaching reputation), (3) entry requirements, (4) employment prospects for graduates, (5) location, (6) available academic and support facilities, (7) social life, and (8) costs of study (Dill and Soo, 2005). The reputation of a university is perhaps a most controversial measure. Organizational rankings can sometimes serve as a useful instrument for public accountability, providing valuable information to both consumers and policy makers. However, the</p>

	<p>rankings are also often heavily criticised as people believe that ranking systems should not dictate university policy but should be used as a source of information for guiding policies according to the needs of the university's own community, traditions, market niche, national role and so on (Taylor and Braddock, 2007).</p> <p>There are three major global university rankings that most people tend to pay attention to such as: (1) Quacquarelli Symonds (QS) World Ranking, (2) Academic Ranking of World Universities (ARWU), and (3) The Times Higher Education World University Rankings (University of Sydney, 2016). Despite the fact they are a variety of different method and sources to derive the results of the ranks, all the major rankings are generally consistent when it comes to outcomes for Australian universities (University of Sydney, 2016).</p> <p><b>(1) Quacquarelli Symonds (QS) World Ranking</b></p> <p>The QS World University Rankings are a ranking of the world's top universities produced by Quacquarelli Symonds published annually since 2004. The QS World Ranking of Universities assesses university performance across research, teaching, employability and “internationalisation” using six performance indicators, which carry a different weighting when calculating the overall scores. The QS system now comprises the global overall and subject rankings (which name the world's top universities for the study of 48 different subjects and five composite faculty areas) (Intelligenceunit, 2017) The subject rankings are intended to address the most frequent criticism of all world university ranking systems, that they contain too little material about specific subjects. The QS rankings use peer review data scholars, academics and recruiters. These rankings have been drawn up on the basis of citations, academic peer review and recruiter review, with the weightings for each dependent upon the culture and practice of the subject concerned (Top Universities, 2019).</p> <p><b>(2) Academic Ranking of World Universities</b></p> <p>The ARWU assesses university performance more heavily weighted to traditional measures of prestige in research, and the world’s most highly recognised researchers, predominantly in the science and engineering fields (University of Sydney, 2016).</p> <p><b>(3) Times Higher Education World University Rankings</b></p> <p>The Times Higher Education World University Rankings judges universities across all the areas of teaching, research, knowledge transfer and international outlook (University of Sydney, 2016). Besides rankings, there are also many other things that also needs to be taken into consideration such as a university with either: (1) a broad range of study options, (2) student and support services, (3) diverse clubs and societies, (4) modern education facilities, (5) a positive culture and (6) an innovative learning environment is essential (University of Sydney, 2016). Hence, rankings can be assessed differently and this needs to be taken into consideration with a range of other factors</p>
<b>Mode of Study</b>	<p>Students can either be studying full-time or part-time due to various reasons and commitment. This can distort statistics as students may be employed currently and be studying simultaneously. This can be due to a variety of reasons and demonstrates that employment may not be all dependent on tertiary education qualifications. On the other hand, not to include such students, also impacts the statistics.</p>

<b>Subject of Study</b>	Employment rates of graduates vary from discipline to discipline. Subject mix will considerably affect the employment rates of an institution's graduates as an institution may specialise in a specific study area and lack in other areas (Harvey, 2001). Some institutions have good employment rates because they specialise in areas that are in higher demand in today's society such as pharmacy, computer science, mathematics, optometry, whereas others rank lower due to specialising in important but lower demand qualification.
<b>Previous work experience.</b>	Prior experience is a major factor for many recruiters today as it means that the individuals have exposure to work-life, and thus have acquired some required skills. This experience could be as a result of previous work (e.g. previous full-time job or extracurricular work) and is usually independent to the institution of study. However, today more institutions are trying to incorporate these practical experiences and skills within their educational curriculum in-order to increase graduate employability rates. Macquarie University, is an example of an institution which has adapted a practical element called Professional and Community Engagement (PACE) to provide their graduates a competitive edge within the workforce. Graduate recruiters are increasingly attracted by new graduates with work experience as part of their programmes of study (Harvey et al., 1997a, 1998), and thus adaptation of these within the curriculum will be a vital step in increasing employability rates for graduates (Harvey, 2001)

*Appendix 2 - Measuring Employability 1*