Identifying demographic predictors that influence pass rates of students undertaking a blended online minor award at third level in an Irish context.

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Abstract

A significant amount of research has been done on metrics with regards to predicting academic success, especially internationally. At the same time very little research has been done on finding predictors for academic success specifically for blended online learning in Ireland. This research aims to identify demographic predictors that influence pass rates on a blended online minor award at third level in an Irish context and this is the research question.

To identify these demographic predictors four main objectives have been employed. First, the literature has been consulted to find the paradigms and identify possible paucities. Secondly, null hypotheses have been constructed from the literature review. Thirdly, the null hypotheses are tested through quantitative research methods. The hypotheses are tested using historical demographic data from students who applied in the years 2015 and 2016.

Finally, the findings from the primary research will be compared to the literature.

This research does not answer why some demographics have an influence on pass rates.

From the research it was found that prior math grades (grades before third level education) are a very common and reliable predictor for academic success. The second demographic predictor that was identified, age, has some correlation to academic success but is not statistically significant. The final demographic predictor, years of relevant work experience, has a strong correlation with academic success.

Concluding from this it can be said that prior math grades are the most important variable that should be consulted when reviewing student applications. Followed by years of relevant work experience and age.

It would be recommended to do more research into educators understanding of blended online learning and to have a clearer definition of blended online learning. This is currently especially important in the context of Covid-19. The second recommendation would be to do more research in why there is a discrepancy between years of relevant work experience and age and how they don’t always have a linear relationship to academic success.

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To quote David Robert Grimes; ‘Very little worthwhile ever happens in isolation’.

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1.0 Introduction

Research Aim – Objectives and Justification

The researcher is the coordinator for the researched programme and reviews prospective students and decides regarding the successfulness of the application. To make this decision the researcher must go through the application form and in most cases a curriculum vitae. This process is time consuming since, on average, more than 120 applications must be reviewed per year. The aim of this research is to find demographic predictors for academic success that can be consulted during the application process to speed up the decision-making process. These demographic predictors or variables are part of the application form, and include: age, address, work experience and prior education.

Ultimately, the researcher wants to expedite the approval process by consulting variables such as age, work experience or prior education to make a balanced judgement as to whether a student will pass or fail the programme. It may also have the added benefit of leading to higher retention rates which would be of benefit to the institute. A further consequential result can be that this will create a more homogenised group with similar cognitive abilities. The benefit of this can be that students will progress at the same rate which can make teaching more effective (Yang et al.2016).To be able to do this the researcher needs to answer the research question; What are the demographic predictors for academic success on a blended online minor award in an Irish context.

Objectives

To answer the research question the researcher will have to follow a certain path and execute the following activities. First of all, the researcher will conduct an extensive review of the literature to determine the paradigms regarding the different themes in this research. From this review some null hypothesis will be constructed. These null hypotheses will be quantitatively tested on primary data to prove if they need rejecting or not. Finally, these findings will be compared and contrasted to the literature review.

1.0.0 Background and context of the research

Online blended learning is increasing in popularity and has been identified as an effective way of delivering course content (Johnston 2018). This mode of learning will be further explained in the literature review. Due to Covid-19 there is a further need and interest in alternative ways to teaching compared to face to face or conventional teaching (Bao 2020). When considering the changes within the educational landscape due to Covid-19, this research gains in its relevance. Also, research on this topic in Ireland has not been identified so apart from this research having an influence on the coordinator of the examined programme it will also contribute to some extent to the bank of knowledge in Ireland with regards to blended learning.

1.0.1 Research Site

The research site is a third level Irish institute of technology that has been anonymised for ethical reasons. The programme that is being investigated is a one-year certificate (minor award) at QQI level 6 and will be referred to as 'the programme'. A more concise description of the research site and the programme will be discussed later in this dissertation.

1.0.2 Research Participants

The participants in the research are historical students from the years 2015 and 2016. When these students applied for the programme, they had to fill in an online form and the data from these forms has been used as a primary source of data to conduct the research. This data consists of variables such as age, years of relevant work experience, prior qualifications and grades or who is paying the fees. Information such as address and contact information is not used in this research. When students do get registered, they give consent to use this data through a signed privacy statement. This allows the institute to run statistical analysis on the data regarding retention rates amongst other things.

1.2 Structure of Thesis

The chapter following the introduction will review the literature. The literature will be examined in a themed structure. The themes are extracted from the title of the dissertation. This will create an insight into blended online learning, demographic predictors, minor award and the definition of success in this research.

In chapter three the research methodology will be justified. Within this there is a clarification of why quantitative methods have been used and which statistical method has been chosen. This chapter includes a step by step approach for selecting the methods based on the 'research onion' (Melnikovas 2018). This model uses 'layers' of research concepts such as: philosophy, approaches, strategies, choices, timeline and concludes with techniques and procedures. Using this model makes sure that all aspects within the research methods are covered and follow on from one another in a logical way (Melnikovas 2018).

Chapter four presents the findings of the research and investigates the meaning of the quantitative analysis with regards to using predictors for academic success. The findings are presented for the three different hypotheses stated in the literature review.

The fifth chapter offers the statistical analysis where quantitative methods and logistical regression is used to test the hypothesis mentioned earlier.

The final chapter discusses the main conclusions and recommendations that have come from this research.

2.0 Literature review

The literature review is of a themed nature and these themes are: what is blended learning?, defining a minor award, the nature of blended learning in Ireland and demographic predictors and academic success. These themes will be explained and put in context to limit ambiguity and to give the research focus and meaning. The purpose of this literature review is to find out which predictors of academic success have been identified and how they relate to this study. The literature review is also used to determine if there are any trends in the field of predictors of academic success such as predictors that can reliable be applied (high external validity) to different field of study. Not all predictors of academic success identified in the literature will be used in this study. A selection of useable predictors will be made for this study based on relevance in the literature and available data for the research.

This literature review will conclude with several hypotheses regarding demographic predictors that will be used in this study. These hypotheses will be tested later in this dissertation. Eventually this will lead to answering the research question, which is to find demographic predictors for academic success on a minor award on a blended online minor award at third level in an Irish context.

2.0.0 What is blended online learning

Blended online learning is a specific form of learning and evolved from a blend between online learning and face to face learning (Harting and Erthal 2005). Face to face learning in this context means, traditional classroom teaching where one teacher would stand in front of a classroom (Siemens *et al.* 2015). Online learning refers to learning with a computerised element in it (Yamagata-Lynch 2014; Margolina and Bohnsack 2019) and communication via the internet. In the period between 2006 and 2008 the description of blended learning has gone from being a combination of face to face learning and e-learning (learning using technology of some form) to a mix between face to face learning and online learning (Saykılı n.d.2015; Schlosser and Simonson 2006). Hybrid learning is another term that has been used but less often then blended online learning (Saykılı 2015). Hybrid learning is also defined as a mix between face to face learning and e-learning (Park *et al.* 2019). The term hybrid learning is also often used in machine learning and artificial intelligence (Meng Joo Er and Chang Deng 2005). Because of this ambiguity the term hybrid learning will not be used in

this document from this point on. The reasons why the terminology has changed over time is not clear. This change in terminology will not be considered in this research as it has no relevance to the research question.

Blended learning combines traditional classroom learning with online learning methods and the literature is relatively clear about this definition (Broadbent 2017; Kristanto *et al.* 2017; Margolina and Bohnsack 2019). On closer analysis of the term 'blended online learning' it seems that the term can mean more than one thing. The proportion between online and face to face lecturing is not defined as clearly and could be better described. Online learning is different to face to face instruction and a 90% online to 10% face to face ratio will require a different andragogy or pedagogy than a 90% face to face and 10% online (Shu and Gu 2018; Wang *et al.* 2019). For example online learning can have synchronous and asynchronous delivery, synchronous may consist of live lectures whereas asynchronous would deliver recorded lectures (Beyth-Marom *et al.* 2005). These different delivery methods can have an effect on the students (Chen and Lu 2013; Margolina and Bohnsack 2019). This could also apply to assessment (Jiao 2015). The assessment and delivery modes are not clearly defined in the literature and might need further investigation but this will not be covered in the research as it is not pertinent to answering the research question. Allen and Seaman (2016) suggest that between 30% and 80% of the course should comprise of online delivery and the remaining part face to face for it to be blended learning. From the discussion above it can be concluded that the ratio between online and face to face is not fixed and the programme under investigation fits the definition of blended online learning.

Harris *et al.* (2009) finds that in third level education there is a clear picture of what face to face teaching is and online teaching. Blended learning is not as clearly described in the literature. Graham *et al.* (2013) also found that some institutes implement technology enhanced learning and call it blended learning. Technology enhanced learning is pedagogical field where technology is applied to learning with the goal to improve the overall learning experience (Spector *et al.* 2016; Butler *et al.* 2017). Technology enhanced learning is however very different to blended learning as technology enhanced learning does not replace face to face teaching time whereas blended learning actually reduces face to face teaching time (Chen and Lu 2013; Hofmann 2018). For this reason comparing studies can be unreliable as the definition of blended online learning is not universal.

For the purpose of this research and the programme being researched the general definition of blended online learning will be used as most frequently stated in the literature (Saykılı n.d.; Schlosser and Simonson 2006; Chin 2019). This definition being: Blended online learning is a mix between face to face teaching and online teaching methods. The reason for adopting this definition is because the researched programme consists of a blend between face to face teaching and online teaching.

2.1.1 History of Blended Learning

The introduction of technology into face to face learning started in the 1960's in the private sector where multi-national companies such as IBM used mainframe computers to speed up and increase the delivery of training courses (Rocher C. Schank' 2020). Companies would deliver face to face training in the classroom and students would learn through technology in their own time (J Bersin 2020). The mainframe (in-house rack computers) based training was then followed by satellite based video learning, CD-ROM, web based E-Learning and we can now enjoy integrated blended learning through multiple forms of media where information can be delivered, topics discussed and assessment done remotely on a virtual learning environment (VLE) (J Bersin 2020). By the mid 1980's the use of technology in the traditional class/lecture room became more widespread in secondary and third level education (Breen 2018).

Third level education institutes have been interested in distance education for some time now for a range of different reasons (Heisman 2020). This interest can be motivated by the possibility of reaching out to larger part of the population and therefore aspiring to social justice (Broadbent 2017) or financial gains due to lower cost in delivery and lower cost for the student (David J. Deming *et al.* 2015). In the more recent years of the blended learning journey, technology has played a significant role because technology has given flexibility and opens education up to students who would otherwise not have access to education due to work or family obligations (Hovdhaugen 2015). With the arrival of the internet students can enjoy a plethora of media platforms including: MOOCs (Massive Open Online Courses), OERs (Open Education Resources) blended programmes, online courses, virtual reality, adaptive platforms and many more (Saykılı 2015.).

2.1.2 Future of blended learning

Including technology into face to face teaching in recent years has drawn a lot of attention and has opened different paths such as blended learning (Rasheed *et al.* 2020). Rasheed (2020) claims that blended learning is the most popular and effective way of delivering programmes. This claim is based on the flexibility, timely and continuous learning that blended learning offers. Claims of this magnitude have not been found in any other papers. The advantage of blended learning compared to online learning is because online students rely more on self-regulated learning whereas blended learning offers more structure and students have more interactions with their instructors (Broadbent 2017). Hofmann and Jennefer (2018) go as far as to say that 'Today all learning is blended learning'. As with Rasheeds' 2020 paper claims of this magnitude were not found in any of the other papers reviewed.

Contrary to this, it seems that there are some disadvantages to blended learning. Blended learning can also have negative effects on both lecturers and students. Blended learning can increase workload on lecturers who now have to introduce new platforms and structures to their teaching material and training in this might be required (Chen and Lu 2013). Chen and Lu (2013) also conclude that from a students' point of view the cognitive workload can increase, especially if these students are used to textbooks for example. Secondly blended learning can have a negative effect on learning styles and working conditions. A study by Kwak *et al.* (2015), where face to face students results of the assessment were compared to blended learning showed that face to face taught students performed significantly better than blended learning taught students. In this study two hours of face to face time had been replaced by online learning where students must perform online tasks. The study then looks at assessment results and student satisfaction. This study simply takes out one part of the delivery and replaces it by another mode of delivery. This study did not consider how important it is to integrate the online element in the design phase of the module to create blended learning as opposed to simply replacing conventional teaching time with online time (Yongxing 2008; Eiliv Hauge *et al.* 2011). Weighing up the pros and cons of blended learning and its' future it can be said that if the blended approach is well designed and implemented, it will have a positive outcome in the students experience and meeting the learning outcomes (Bylieva *et al.* 2019; Keskin and Yurdugül 2019; Rembach *et al.* 2019).

Jowsey *et al.* (2020) assert that due to the Covid-19 pandemic it clear that the online component of blended learning is very valuable so students can continue to interact with the curriculum material. Another benefit to blended learning is its' reduction of cost in the deliverance of a module as face to face time is reduced and students might be able to save money on not buying textbooks (Johnston 2018).

2.2 Trends in the literature

To determine which papers have been most influential in the last decade a systematic review by Halverson *et al.* (2012) will be examined. This paper explores two fundamental aspects of the research: the methodologies employed and secondly, the range and frequency of the studied topics. The second point also explores what the most used theories are that scholars use to support their study. This study analyses trends in research, dissertations and theses on the topic of blended learning and tries to identify gaps in the literature. One of the main conclusions of this paper is that most of the research that has been done is conducted at third level education and this trend has been consistent since 2001 (Drysdale *et al.* 2013). This study examined primary education, higher education and corporate education. This study also concludes that inferential statistics (data analysis) is the most used research method for identifying predictors for academic success. Inferential statistics combined with quantitative methods come second and qualitative comes third. This study also concludes that most research has been done on practical levels and theory seems to be investigated to a lesser extent and that investigations should be done at a theoretical level. Many studies involve programmes delivered in the US and there is a relative paucity of research related to Ireland (Crompton 2013). From a review of the literature is has become evident that not much research has been completed on discovering what the predictors are with regards to qualifications or work experience at the time when a student embarks on a study using blended learning methods (Carroll 2011; Cloonan and Hayden 2018). Most studies which focus on retention in online programmes look at factors such as engagement (Sun and Rueda 2012), relevance of programmes (Falloon 2011), personal factors (Park and Hee Jun Choi 2009), institutional factors (Betts and Betts n.d.), and what a lecturer can do to increase retention. For this reason it could be possible that this piece of research will make a useful contribution to the bank of knowledge of blended online learning. Furthermore, the admission

process is the first step in prospective students going to third level education. Institutes could make better use of admission information to ensure that students succeed and thus increase retention.

2.3.0 Blended Learning in Ireland.

QQI (Qualifications and Quality Ireland) has published guidelines for blended learning in Ireland and it is called, Statutory QA Guidelines for Blended Learning Programmes. This document defines blended learning as 'The integration of classroom face to face learning with online learning experiences'. This definition is in line with most of the literature reviewed except for some literature that dates before 2006 where the word online is sometimes replaced by e-learning (Saykılı 2015; Hofmann 2018; Bylieva *et al.* 2019). E-learning is short for electronic learning. Because the QQI definition is in line with the literature and it relates to an Irish context, it will be used as such for the purpose of the research. This document also provides guidelines regarding plagiarism, redundancy of hardware and software, students outside Ireland, assessment strategies etc. This document does however not specify what the proportions are between online and face to face teaching.

A study at Galway Mayo Institute of technology (GMIT) found that the introduction of blended learning had a positive effect on students if the lectures are delivered synchronously (live interactive online lecturing) and face to face teaching was utilised during lab time (Cloonan and Hayden 2018). This study also points out the benefits of students being able to view material multiple times. This study concluded that the blended approach is less stressful. A paper by the National University Ireland Galway (NUIG), where student satisfaction is researched, concludes that blended learning enhances the student experience (Hahessy *et al.* 2014). A study by Carroll at GMIT revealed that the use of asynchronous material in IoTs all over Ireland is not used to its full potential (Carroll 2011). This is confirmed by Yamagata-Lynch (2014) who asserts that synchronous delivery is preferred by students over asynchronous (recording of live lecture) delivery.

2.3.1 Blended Learning Trends in Ireland

In Ireland there are two major organisations that concern themselves with technology and learning. First, there is the Irish Learning Technology Association (ILTA) and this organisation publishes the Irish Journal of Technology Enhanced Learning. As pointed out before, technology enhanced learning is not the same as blended learning and the open, peer reviewed journal does not include any articles regarding blended learning ('Irish Journal of Technology Enhanced Learning' 2020). A source that does include Irish papers, the second organisation, regarding blended learning is AISSHE-J (All Ireland Scholarly Higher Education Journal). After reviewing papers from AISHE-J it has become clear that most research has been done on a practical level like measuring students' satisfaction or comparing results with or without blended learning (Carroll 2011; Ring and O'Sullivan 2019). This is in line with international research (Harris *et al.* 2009; Johnston 2018; Rembach *et al.* 2019). Online data bases revealed an Irish article on blended learning and Continuous Professional Development (CPD) in the construction industry (Wall and Ahmed 2008). This search also yielded papers on blended learning in primary schools (Ring and O'Sullivan 2019), blended learning for entrepreneurs (Lynch *et al.* 2013), successful implementation (Harris *et al.* 2009), teacher professional learning (Butler *et al.* 2017), comparing blended learning to online learning (McCutcheon *et al.* 2018) and a study regarding student satisfaction within blended learning (Smyth *et al.* 2012). From these findings it could be concluded that in Ireland a relatively small amount of research has been conducted but the research that has been done is recent and this could mean that blended learning is getting more attention in Ireland. The oldest study that was found dates back to 2006 and concerns research into blended learning on a post graduate diploma programme for teachers (Donnelly 2006). No Irish study was found that investigates the demographic predictors for academic success in blended learning, where success is defined as passing a programme or not.

2.4 Online blended learning for this research.

This study is being conducted by the coordinator of the aforementioned programme. This emphasises the importance of the study as the programme coordinator is in a position to suggest possible changes to the programme to increase retention rates. Any possible changes

will have to be discussed in a program board meeting. McDermott (2017) states that online blended learning is growing in Ireland and it is important that the Institute keeps its head start in the field by having an insight into online student retention and having measures to maintain this (Strategic-Plan-2017-2022 n.d.). It is the institutes' ambition to grow the number of online students from a ratio of 60% fulltime and 40% online to a ratio of 60% online and 40% fulltime before 2022 (Strategic-Plan-2017-2022 n.d.). For the faculty of Engineering and Design the number of online students has overtaken the number of fulltime students. Statistical information on retention can be used as a 'sales' tool to promote online learning at the Institute. The need for part-time and flexible education has also been recognised by the Higher Education Authority (HEA) as they published a policy document in 2012 (Part-time And Flexible Higher Education in Ireland) in which the importance of flexible and part-time education is emphasized (McDermott 2017) Currently the Covid-19 pandemic makes the need for flexible education even more relevant (Bao 2020).

2.5.0 Minor award

Quality and Qualifications Ireland (QQI) describes different types of awards at third level (Descriptors - minor, special purpose, supplemental). This document defines Minor, Special and Supplemental awards. Minor awards are always part of a major award and also have relevance in their own right. The amount of student effort needed for this type of award will be smaller than the amount of effort required for the major award that they can be part of. The amount of credits rewarded for this type of award depends on the awarding body. Special purpose awards are designed with a relatively narrow scope in mind and can, but don't have to, be part of a major award but they would be better defined as standalone awards. Special purpose awards would typically focus on the skill side of a strand in a learning outcome. Students do not graduate but will instead pass or fail the minor award.

This means that a minor award yields a considerably lower amount of credits then a major award and at the same time substantially more credits compared to a special purpose award. Supplemental awards would be an addition to a major or special award and would typically be at the same level. For all three described awards the amount of credits gained can be determined by the awarding institute.

A major award would typically earn between 120 and 180 ECTS this could be a Higher Certificate or a Bachelor's degree and would be the result of 2 and 3 years fulltime study respectively.

2.5.1 Minor award for this research

The programme that is researched/analysed is designed as qualifier to advance to a blended online learning bachelor's degree in Mechatronic Engineering at the research site. This brings the programme in line with the guidelines from QQI where minor awards are being described as part of a major award (Descriptors - minor, special purpose, supplemental). However, this minor award also has merit on its' own. In this one year blended online programme students will have online lectures in the evening that are typically selected from the second year of the BEng. in Mechatronic Engineering. The selected modules for this year are directly related to the level 7 mechatronic engineering so that students can seamlessly progress from level 6 to level 7. As most of these students have not been in formal education for a long time, they will commence in a yearlong maths module. On completion of the programme the students will not graduate but they will gain 30 European Credit Transfer System (ECTS) and are eligible to progress to level 7 in Mechatronic Engineeering. This programme is very well suited to students who did not academically progress after the leaving cert but did gain a lot of relevant industrial experience. For this reason the students who apply for the certificate have very different backgrounds and this would not be typical for a programme aimed at mature students (Park *et al.* 2019). As part of the induction process students are invited to campus where they can meet each other and become familiar with the online element (VLE) and other housekeeping elements of the programme. The students must attend two practical sessions per semester on campus. The practical sessions are compulsory and include some assessments. On these days the students partake in a morning lab and an afternoon lab. Other practical work is done from home and students must purchase the relevant equipment. Information regarding the research and the nature of the programme site will be given in the research methodology section. Having defined what a minor award is, the next section we will examine the concept of demographic predictors for academic success.

2.6.0 Demographic predictors for success

This section is structured as follows: First the term success is defined, second the term demographic will be put in context, third the literature will be consulted to identify which predictors for success have been researched by other people and finally the available predictors for this research will be identified.

What is academic success? For the purpose of this study student success is defined as passing the programme or not. Factors such as grades, student satisfaction or relevance of the programme are not considered. This research will not identify if students failed because they did not participate in an exam or scored below the mark for passing a module, in other words this research will not identify if a student dropped out or if the students failed a module or why they failed. These factors are not included because the researcher does not have access to this information and time restrictions do not allow the researcher to get this information. This study will not include why students failed as other studies have done by including factors such as course design, instructor facilitation or institutional factors (Bawa 2016; Keskin and Yurdugül 2019; Muljana and Luo 2019). These factors have been omitted because of time restrictions.

2.6.1 Demographic

Demographic characteristics can be defined as age, gender, or if English is a student's first language (Yukselturk and Bulut 2007; Kaddoura *et al.* 2017). Yukselturk and Bulut (2007) also includes educational background and Yang and Hsieh (2013) researched how regional background affects students' performance. Studies by Schulze and Roberts (2006); Trapmann *et al.* (2007) have been identified that research of the 'Big Five' on academic success but these factors, neuroticism, conscientiousness, extraversion ,openness to experience and agreeableness are considered not demographics but lie in the field of psychology.

2.6.2 Predictors from other studies.

Predictors for success is one of the metrics that many scholars look for to get an insight into why or how students achieve success (Borgman 2020). Once these predictors are identified and understood one can intervene to improve factors such as student retention or student satisfaction (Hao *et al.* 2014). And this can lead to an improved experience for students, lecturers or even an institute.

Several papers have been written on the subject of predictors of academic success with different perspectives and findings (Harris *et al.* 2009; Park *et al.* 2019). Many of these studies look into factors such as motivation, institutional factors or course design (Greene *et al.* 2015; Kauffman 2015; Nam *et al.* 2018). Kauffman (2015) concludes in her research that adequate management of feelings, self-regulating skills, self-discipline, time management, organisation and planning are essential to succeeding in blended online learning and she finds this confirmed in at least six different studies (Muilenburg and Berge 2005; Waschull 2005; Eom *et al.* 2006; Kerr *et al.* 2006; Yukselturk and Bulut 2007; Ruey 2010). These outcomes are not surprising as in blended learning a higher level of discipline is required because the flexibility that the system offers can have pros and cons (Keskin and Yurdugül 2019). Greene *et al.* (2015) highlighted the importance of the students' perception of the instructor, course material and assignments. This study did not include factors such as gender or prior educational results and this study is based on a MOOC so it cannot directly be compared to a fee-paying programme. Greene *et al* (2015) does, surprisingly, see no relationship between age, work experience and dropout rates. Alstete and Beutell (2004)find that age, work experience and grades have an impact on academic performance. This same study also concludes that factors such as SAT (Scholastic Aptitude Test) and GMAT (Graduate Management Admission Test) are not related to performance in blended courses.

This might confirm that a MOOC cannot be compared like for like with a fee-paying programme. The Alstete and Beutell (2004) study also contradicts a study by Morris et al. regarding SATs and GMATs (Morris *et al.* 2005). The Morris study did see a positive relationship between the Scholastic Aptitude Test and performance in online programmes whereas the Alstete and Beutell study did not. At the same time one can conclude that further studies would be justified to find out more on this topic, this is however outside the scope of this research work. A 2016 American study on predictors of academic success concludes with

a clear relationship between age and academic success (Vella *et al.* 2016). This would be more in line with findings of other studies that have been reviewed (Greene *et al.* 2015; Kauffman 2015).

2.6.3 Demographic predictors for this study

The demographic predictors that this study has found are based on variables that are identified from the literature which are relevant to predicting if a student will pass or fail in a wider scope of academic success research. From the literature it has become clear that factors such as age, gender, previous level of education, regional differences, motivation, time management skills, and institutional factors such as: course relevance, instructor perception by the students and administrative support all have an influence on retention and/or attrition (Kauffman 2015; Vella *et al.* 2016; Park *et al.* 2019).

For the purpose of this research not all these variables will be considered as not all this information is available to the researcher. For this study demographics such as age, gender, nationality, previous education and number of years of work experience are available to the researcher from two historical academic years (2015 and 2016). As part of the research, null hypotheses will be constructed and these hypotheses will be tested in the analysis section of this document. In the analysis a comparison will be made between the findings of the literature review and the actual research so some findings and conclusions can be described.

The next section will examine the literature on the variables mentioned above and the corresponding null hypotheses and alternative hypotheses.

2.7 Age and academic success

Vella *et al.* (2016) finds that students who are older (40 years plus) perform better in blended programmes than students who are younger, regardless of gender. Conversely this is not the case for fully online programmes. Amuda *et al.* (2016) tested the null hypothesis; Age is not a significant predictor of academic performance. This hypothesis was found to be correct. A similar hypothesis was tested by Kimeli *et al.* (2019) and in this study the null hypothesis has

been rejected. The difference in findings is due to the fact that the Vella et al. (2016) study investigated blended online learning and the Amunda et al. (2016) study investigated a fully online programme. This finding is in-line with other studies that compare blended online with fully online learning (McCutcheon et al. 2016). Vella *et al.* (2016) concludes that age and gender are mayor contributors to academic success and does not take previous academic performance into account. This finding contradicts the findings of a study by Yukselturk and Bulut (2007) who conclude that there is no correlation between age and academic performance. M. and M. (2014) found that the average age of a successful students to be 28 as opposed to an average age of 25 for a non-successful student. The Yukselturk and Bulut (2007) study could be contradicting because the investigated group had a relatively small spread in age (18-21) where the other studies had bigger age differences (22-40) The afore mentioned papers give an indication that age can or cannot have a deciding influence on academic success. However, because the programme investigated is a blended online programme the emphasis will be on studies that were conducted in blended online programmes and the null hypothesis will therefore be;

Age does not have an influence on academic success.

2.8 Gender

The studies reviewed could also include the variable gender. However, the programme researched does typically have a very small number of women on it or none at all (typically less than 1.5%). For this reason, the variable gender will not be discussed as the sample size is too small (Faber and Fonseca 2014).

2.9 Nationality and academic success.

The third variable that the researcher has to his disposal is nationality. As the researched programme is delivered through the English language, native speakers could perform better than non-native speakers (Street 2017). Even though the researcher has access to the nationality of prospective students, this information does not include their level of English. For this reason the variable nationality has not been included in the research.

2.10 Prior grades (at secondary level)

McKenzie and Schweitzer (2001) come to the conclusion that previous academic performance is the mayor predictor for academic success followed by integration into university and self-efficacy. This is also the conclusion by Zheng *et al.* 2002), but this study did not take integration into university and self-efficacy into account. The same goes for (McCall *et al.* (2006) and Onwuegbuzie *et al.* (2000). These studies have been conducted in different disciplines of academic study and all seem to find that regardless of the subject a student studies, prior academic success is a major predictor of future academic success. However, (Derr *et al.* (2018) conclude in their study that within engineering prior math grades are very relevant to academic success. This study finds that math grades have a closer correlation to academic success than overall prior academic. This finding was confirmed by several other studies (Buechler 2004; Derr *et al.* 2018; Sheridan *et al.* 2020). For this reason math results are chosen because of the specific correlation with academic success in engineering.

Having reviewed the literature on prior grades, the second null hypothesis is constructed*;*

Prior math grades are not a reliable predictor of academic success.

2.11 Years of Relevant Work Experience

For the purpose of the next hypothesis years of relevant work experience will be defined as years of experience that relate to the researched engineering programme. In other words, years of experience in process control, manufacturing, building controls or other engineering disciplines. Adams and Hancock (2000) found that years of work experience had a greater influence on academic success than prior academic results and Braunstein (2002) finds evidence to support this view. The students that would apply to the researched programme would typically have some years of relevant work experience and this variable has a positive influence when considering students for the programme during the admissions process. For this reason, a null hypothesis is constructed regarding work experience;

Relevant work experience does not influence academic success.

The three hypotheses will be tested in the analysis chapter of this document.

3.0 Research methods

This chapter expands on the research methods employed. The research aims and objectives are explained in this section, as is the context of the research. To further examine the research methods the research onion structure has been used to indicate the chosen methods. This includes, philosophy, approach, choices, time horizons, techniques and procedures and their justification (Melnikovas 2018). The research onion is a layered metaphor for a model which gives a step by step approach of how to construct an appropriate research approach. This chapter also includes research site selection, describing the anonymised research site, participant selection and research limitations. Reliability and bias are included next to demonstrate considerations of objectiveness.

3.1 Introduction

The researcher is the coordinator for the programme researched and the coordinator decides which students are successful in their application and which students are not. To determine this, the coordinator must look at the data supplied by the applying student. The coordinator has to manually evaluate many variables in the application and this is time consuming. To reduce the time taken to evaluate these applications it could be a considerable advantage to have reliable predictors for academic success. A subsequent advantage might be that the cohort is of a more homogenised nature with less students that 'struggle' and slow the rest of the group down. Having good predictors for success can also increase retention rates which is of interest to the institute. The above mentioned are the justification for the research.
The researcher developed several hypotheses from the literature review based on the research question. These hypotheses are related to the predictors for academic success. For example, a hypothesis from the literature can indicate a correlation between a higher age and academic success. This hypothesis will then be tested using the available data from the relevant programme to find out if the hypothesis applies to the minor award researched. The hypothesis will be developed from the information that is available from the database of student applicants. This way the researcher hopes to find some reliable metrics to gain an insight into which applying students should be offered a place on the programme and which students should not. At the same time the researcher is comparing results from the literature

to practice from the researched programme. Quantitative research methods have been used to test the hypotheses and the justification for this is clarified later on in this chapter.

3.2 Research Aims and Objectives

The aim of the research is to answer the research question. The abridged research question is; what are the demographic predictors for academic success. These predictors can be variables such as age, previous education or work experience for example. In summary, the aim of the research is to identify demographic predictors of academic success.

The objectives of the research are defined by the 'how 'i.e. how the researcher will achieve these aims. Part of achieving the aims is to review the literature as seen in the previous chapter. In this chapter common predictors for academic success have been identified and a selection of predictors available to the researcher have been found (i.e. age, years of relevant work experience and previous math grades). From the literature review three hypotheses have been constructed.

The second objective, as part of the research methods, is to use an appropriate research method to test the null hypotheses.

The third objective is to apply validity and reliability test on the available data. This will be done by applying a statistical *t* test to the analysed data to make sure that the available data does not contain 'wild' fluctuations.

The fourth objective is to compare and contrast the findings to the literature. The fourth objective is highlighted in the findings chapter.

The second and third objective will be described in more detail in the analysis chapter.

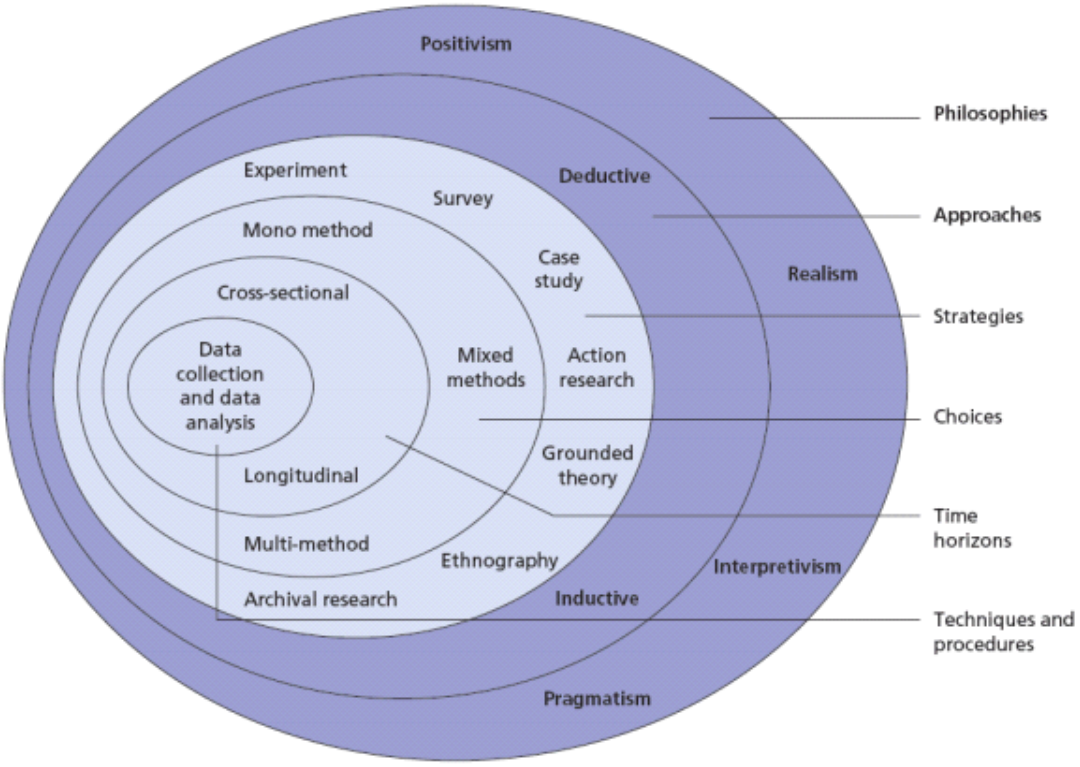
3.3 Context of the research

Regardless of the research topic, techniques or methods, context gives meaning to research and is therefore very relevant (Wyld and Jones 1997). This research applies to an Institute of Technology in the North West of Ireland with students enrolling on a minor award from a variety of counties in Ireland and abroad. The students who enrol have a very diverse background when applying, ranging in age, work experience and previous education. The

investigated programme is of a blended nature with most of the lectures delivered online and the students visit the campus four times in the two semesters to perform practical classes.

3.4.0 Research Methodology

To illustrate how the researcher came to the applied research method, the research onion will be used as a structure, starting with the outer layer, Philosophies, and ending with the techniques and procedures. The research onion is illustrated below in Figure 1



Source: Adapted from Saunders et al. (2009, p.108)

Figure 1-Research Onion

3.4.1 Philosophy

The current research philosophy paradigm, positivism is strongly related to quantitative methods where qualitative methods would have strong connections to interpretivism and constructivism (Yazan 2015). In addition to quantitative and qualitative methods a more

recent method has been accepted as part of pragmatism and is called the mixed methods where qualitative and quantitative methods are combined (Ivankova and Stick 2006). Based on the research question and the available data (numerical data) a quantitative research method has been selected. It has also become clear from the literature review that quantitative methods are often used in research regarding predictors or correlation research (Zhu *et al.* 2018).

This research seeks to examine if there are correlations between demographics and academic success. For this reason, a correlational design is chosen. With this quantitative design method one can use statistical analysis to determine to what degree variables are associated. This method does not allow the investigator to change variables and observe what happens to the outcome as one would in experimental methods (Cook and Beckman 2010). Within correlational methods there are explanatory design and prediction design. Prediction design is the most relevant for this study as the researcher is looking for demographic predictors (Kovacic 2010). However, prediction design primarily has an output variable, or criterion, that can be scaled like average grade with a scalable input variable such as hours studied for an assessment (Quinn and Gray 2020). This way a researcher can determine what the correlation is between hours studied and expected grade at time of assessment. This method does not apply to this research as the criterion variable is of a binary nature, the student passes or fails. The input variable can be scaled i.e. age in this research can vary between 22 and 55 years. Due to this fact a different statistical approach needs to be used, logistic regression (Punch and Oancea 2014).

Logistic regression is a research design that, for example, determines the probability of passing a test versus number of hours studied. The input variable is scalable, for example 0-10 hours of study and the criterion variable results in pass or fail (binary). When applying this research method one can determine statistically what the minimum required hours of study is to pass a test.

This method can also be used for an input variable such as age or years of relevant work experience and a criterion variable such as pass the programme or fail it. This method produces a *p* value that can be used to accept or reject a null hypothesis.

Finally, it is typical in quantitative research to have a small number of variables and many cases, typically one would expect five to ten time the number of variables to cases (Cohen *et al.* 2013). The high number of cases also allows for cases that cannot be used (redundancy) because there will always be some cases that have incomplete information, information is lost before analysing. In this research there are three variables and 112 cases.

3.4.2 Approach and Strategy

Due to the nature of the research the researcher will start using an inductive approach which should result in a null hypothesis or a testable proposition. The null hypothesis will be exposed to a deductive approach by applying statistical tests to determine if the null hypotheses needs to be rejected or not.

As the cases are historical cases the strategy for this research is documentary research. This strategy is chosen because the researcher has two years of historical information that will be statistically analysed to answer the research question from this primary data.

3.4.3 Method and Time horizon

In accordance with the research onion in Figure 1. The methods can be mixed, multi or mono methods. Mixed methods combine different methods such as quantitative and qualitative, multi method applies the same method in different ways and mono methods use pure quantitative or qualitative methods (Punch and Oancea 2014). The research in this dissertation is quantitative only so a mono method is applied.

3.4.4 Time horizon

Cross-sectional research can be described as a ‘snapshot’ of a studied population or sample would typically study different populations or samples whereas longitudinal studies look at the same population or sample and this is repeated over time (Cohen *et al.* 2013). The conducted research in this dissertation fits neither of these descriptions. This study is executed at one point in time on different populations or samples but for different moments in time. It is therefore a combination of longitudinal and cross-sectional and is called a repeat cross-sectional study (Cohen *et al.* 2013).

3.4.5 Techniques and procedures

This section highlights the data collection and analysis techniques and procedures that were adopted in this study.

The historical data that will be analysed comes from two different sources. The first source is the institutes' Customer Relationship Management (CRM) system. All applicants' data is stored in this system and the researcher has access to this data. This data consists of variables such as: age, work experience, date of birth, previous qualifications, primary address, gender and who is paying for the course (employer or self). The data has to be manually extracted from the system into Micro Soft Excel and covers the years 2015 and 2016, with a total of 112 cases. For pragmatic reasons often a sample would be used from a population to save time and cost (Faber and Fonseca 2014). In this study the entire population will be taken into account and this limits the chances of errors. Not all the available variables are used in this research for reasons highlighted previously in the literature review. Only age, years of relevant work experience and previous math grades will be considered.

The second source of data comes from exam board broad sheets. These sheets contain the results of the students after their exams and gives an indication if a student passed the programme or not.

The information from the two different sources will be combined in one spreadsheet to create an overview of students with their demographic profile and pass or fail result.

The data analysed from the institutes' database and broad sheets goes back to the academic years 2015 and 2016. The data analysed still holds relevance as the programme has not changed significantly despite a programmatic review in 2019/2020. Two minor changes are worth mentioning, the first being that on one module some content has been added and some has been removed but it is still a 5-credit module with similar learning outcomes. The second change is that in the year 2016/2017 the group size was increased from 48 to 64 students due to the popularity of the programme. The lecturers on the programme have stayed the same bar one, the researcher.

3.5 Site Selection

The research site is an Institute of technology in the North West of Ireland and for ethical reasons the research site will be anonymised and will be referred to as the Institute.
The Institute first opened its doors in September 1970 as a Regional Technical College (RTC). The college gained Institute of Technology status in 1998 and is currently working towards the status of Technical University in combination with two other Institutes of Technology.
The institute has three faculties: Engineering and Design, Science and Social Sciences. The faculty of Engineering and design would have the largest number of online students.
The research site that will be used for the primary research is the place where the researcher works. The research site has a relatively long history of online learning and is a national leader in this field. The Institute has approximately 6000 registered students and about 2000 of these are online students. The researched programme is part of the faculty of Engineering and Design and within that faculty it is part of the department of Mechatronic Engineering. The programme consists of several modules from the second year of the full-time Mechatronics bachelor's degree. The researched programme is a minor award as explained in the literature review. The fulltime to online student ratio for the Institute in 2017 was 62:38, and the goal for this ratio is be 42:58 by 2022. From these figures one can see that the online growth is ambitious (IT Strategic Plan 2017-2022 n.d.) and any efforts that may result in improving the online retention are therefore valid and appreciated.

3.6 Participant Selection

The demographic predictors that the researcher is trying to identify apply to students who would like to enter a blended online engineering programme. The prospective students would range in age between 21 and 55 years. Some of the students would have qualifications from other countries than Ireland. Applying students may come from countries like Romania, Poland, Nigeria, South Africa, Australia, America and many others. However, most of the applicants are Irish. This means that some of the students have qualifications that are not necessarily recognised in Ireland and can make recognition of prior learning complicated. Levels of English are not considered when reviewing students. Recognition of prior learning

is not conducted by the programme coordinator but by a private company and the coordinator makes decisions based on the advice of the company regarding prior learning.
Personal reasons to commit to the programme vary as well. In most cases students want to use the programme as a qualifier to the Bachelors Degree in Mechatronic Engineering. However, some students could be teachers, procurement officers or people with an interest in the field.
When students apply, they must submit information regarding their work experience, date of birth, previous education, who is funding their study and a CV. All this information is stored in a CRM system that the coordinator of the programme can access. The programme currently has spaces for 64 students and about 100 to 130 students apply every year. Students whose applications are successful but cannot be offered a place on the programme due to capacity limitations will be offered a place on a similar programme, however not all students accept this alternative offer.

3.7 Research limitations

There are many predictors for academic success such as grit, race, region, previous education, age, family background, gender, or marital status (Zheng *et al.* 2002; McCall *et al.* 2006; Aliponga 2016). Not all these predictors are available to the researcher from historical data so to answer the research question variables have been chosen that are available from historical data.

The definition of academic success can also greatly vary. Different studies have different definitions such as satisfaction, GPA, moral development. The definition depends very much on perspective (York *et al.* 2015). For example, success to a head of department might be that a student stays within the institute and progresses to an honours degree or a Masters. Whereas success to a lecturer can be achieving a good result for a module. As the research is conducted from the coordinator of the programme, the definition of success is passing or failing the programme because this is relevant to the coordinator as passing produces students who can progress to the bachelor's degree in Mechatronic Engineering.

The research conducted focuses on three predictors of academic success, being age, years of relevant work experience and previous math grades. No other variables are considered. This has an impact on validity, which is discussed next in the reliability and validity section.

3.8 Reliability and validity

Reliability in research is defined as the consistency of the research or the ability to repeat the research and have consistent findings or measurements (Punch and Oancea 2014). This can be achieved by conducting a test followed by a retest and comparing the outcomes. To increase the reliability of the study, the researcher will use a statistical method (*t*-test) to determine the consistency of the data that is being analysed. The *t* test is based on the coefficient of the means of the two years' data. This data is the information from the CRM system that contains age, work experience and previous academic achievements. The logistic regression that will be applied to the data to determine correlational strength will also be applied twice on data from the years 2015 and 2016. This way increased reliability can be demonstrated.

Validity is in research is defined as the strength of the findings, conclusions or propositions (Cohen *et al.* 2013).Validity can be subdivided into conclusion validity, in this case that would be is there a correlation between the input variables and the output variable. Secondly there is internal validity, this would refer to causal relationship, for example do previous grades cause a higher probability of passing the programme. Thirdly there is external validity and this is defined as how well do the findings transfer to other programmes of even other Institutes of Technology (Dimitrov 2008).

In this research internal validity will not be examined as causal relationships are difficult to reliably establish (Morrison and van der Werf 2020). For example it can be that previous grades have an effect on passing rates (conclusion validity) but this does not mean that every student who has good previous education is guaranteed to pass the programme. It could also be said that factors such as grit or family circumstances contribute equally to academic success. For such a holistic approach to answering the research question one would need a lot more information and time than possible for this dissertation.

External validity or Generalizability will not be examined in this research as there is not enough time to find out how the findings compare to other programmes of a similar nature. Also, very few comparable studies have been conducted in an Irish context.

Conclusion validity will be the focus of this work. The researcher will try to identify correlations between demographic predictors and academic success while trying to avoid bias.

3.9 Dealing with Bias

Dictionary.com defines bias as: ‘an inclination or prejudice for or against one person or group, especially in a way considered to be unfair’ (‘Definition of bias | Dictionary.com’ 2020). Bias can occur intended or unintended. For example if a researcher wants to see if there is a correlation between classroom attendance and GPA through a questionnaire, it could be that students who might suffer from long term illness or have a reputation for not attending are not present for the questionnaire and therefore the these cases are excluded from the research affecting the validity or reliability of the study. This would be unintended bias. The design for this research takes into account that some cases will be omitted but it will be done in a consistent manner. For example, all cases with incomplete information will be omitted.

In some cases, bias is intended and can lead to a preferred outcome of the research with loss of objectiveness and possibly harm to others.

To avoid intended and unintended bias the researcher will consider the whole population as a sample, so no sample selection is made.

If any rounding up of down needs to be done, this will be done in a consistent way, for example years of relevant work experience will consistently be rounded up to whole years.

To avoid bias a researcher should keep ‘distance’ from the cases (Smith and Noble 2014). For this research there is no connection between the researcher and the historical data.

If the researcher does have bias to the cases, then this can lead to ethical issues.

3.10 Research Ethics

In research, ethics are an important part of the brief (Jones 2000). Research should be objective with as little bias as possible to protect the subjects/cases researched and the wider consequences that can follow from research. Special care should be taken when dealing with the very young and the very old or other vulnerable groups (‘BERA’ 2019). Generally, people who take part in research should give voluntary informed consent and these people should be informed of their rights within the study, including where the resulting information is stored and for how long and who this information will be shared with (Harding 2018).

For this research, historical data is used exclusively and the students that applied have now left the institute. This results in a very low impact on the persons involved as they are no longer connected to the institute. The research conducted does not involve any direct contact with the cases and all participant are over the age of 18. The only issue that needs to be considered is GDPR.

All information has been anonymised e.g. names of students and the Institute. The researcher has assumed that all the subjects are alive and therefore GDPR compliance must be adhered to. The researcher has permission from the Head of Department and the GDPR officer to analyse the relevant data. The -to be- used data comes from two different sources. First historical exam results have been analysed and secondly the database with students' application information in it. Permission has been given to the databases, the researcher does not need voluntary informed consent from the students. This permission is not needed because when students apply to the institute the students sign a privacy statement where they agree to have their data used for statistics and analysis. Further to this the researcher's proposal has been approved by the ethics commission of Letterkenny Institute of Technology (LYIT) through the LYIT application form for ethical approval.

The actual research will have a low ethical impact on the past students as these students have finished the programme and the outcome will therefore not influence their future. However, the outcome(s) of the research can have ethical implications (Jones 2000). For example, it could be found that people who apply for the programme over the age of 45 will typically not complete the programme. To increase retention it would be of a logical conclusion to discriminate against people over the age of 45 and this would result in ageism. If the programme coordinator does let people on the programme who are statistically more likely to fail then he or she is discriminating against people who are not of a 'right' age. The outcomes of the research would be biased to discrimination, the coordinator should investigate further on an individual student basis. For example, the coordinator could have a telephone interview with the applying student to investigate Information Communication Technology (ICT) skills.

3.11 Conclusion

The researcher proposes a quantitative research method named logistical regression to determine the correlation strength between the variables age, years of relevant work experience, previous math grades and the outcome, or criterion variable pass or fail. This method will be used to test the hypotheses. Before analysing the data the researcher has conducted a statistical *t* test to determine the level of 'homogenisation' of the data. The researcher will apply logistical regression on two sets of data (from 2015 and 2016) to improve reliability. These methods have been selected due to the numerical nature of the data and research methods used in other studies (Cohen *et al.* 2013). Ethical issues such as and bias, are kept to a minimum by working with historical scalable data in a consistent manner. All issues regarding GDPR are covered through the LYIT ethics procedure to prevent harm to others.

4.0 Research Findings

This chapter presents the research findings and its evidence through the 'lens' of the literature review. The first part of this chapter will describe the findings and how the data has been tested for consistency. The second part will discuss the statistical findings individually for each of the hypotheses. After presenting these findings they will be compared and contrasted to the literature to find similarities or discrepancies.

To inspect the consistency of the data used from the year 2015 and 2016 these were compared using a *t* test. The statistical outcomes of the three different variables were as follows:

- Age: 0.956
- Years of relevant work experience: 0.903
- Prior math grades: 0.856

As these coefficients are very close to the number one, the key finding from this is that it can be safely said that the data is consistent (Punch and Oancea 2014). This way of testing data is commonly used in quantitative research (Punch and Oancea 2014).
After finding that the data was consistent the hypotheses were tested. The hypotheses were tested on two sets of data (2015 and 2016) to improve reliability (Kuncel *et al.* 2007). The findings of testing hypothesis A is given below.

4.0.1 Null Hypothesis A; Age does not have an influence on academic success

After employing logistical regression statistics on the data from 2015 a *p* value of 0.6997 was obtained. From this it can be said that the null hypothesis should not be rejected. One must be aware that this does not mean that the alternative hypothesis should be accepted (Punch and Oancea 2014) From Figure 2 and 3 (in research analysis) it can however be seen that there is a slight connection between age and academic performance but according to the logistical regression model, this relationship is not statistically significant (Cohen *et al.* 2013).

When running the logistical regression model a second time on the data from 2016, a *p* value of 0.4660 was obtained.

When statistically comparing these two *p* values using a *t* test, a value of 0.665 is obtained and it can be said that this *t* value has no significant statistical significance.

4.0.2 Comparing and contrasting the research findings to the literature for hypothesis A.

Keskin and Yurdugül (2019) describe in their findings that age does have an influence on academic success. Even though the current study is very similar to this study, there are some key differences that could explain the different outcomes. The first difference is that the Keskin and Yurdugul divided the subject up in three age categories whereas the current study looks at every subject individually. Also, different statistical methods have been used. These differences however do not completely explain why the outcome of the current study differs from the Keskin and Yurdugul study. What could explain the difference in outcome is the fact that more than 60% of the subjects in the Keskin and Yudugul were between 20 and 24 years of age and the remaining students were no older than 29 years of age. The subjects in this study have a much higher age profile with the oldest students being 55 years of age. From this it could be concluded that the influence of age becomes smaller as students pass for fail. To look for evidence of this suggested explanation further literature needs to be examined. Abbie-Rose Imlach *et al.* (2017) studied older (means of 60 years) students and how their age affected academic success. This study did not find that older students did less well than younger students. To be objective, it needs to be noted that this study had a majority of woman in it (72%) and this could also influence the study results (Dinan 2016). Vella *et al.* (2016) also finds that age has a positive effect on academic success. It can be said that the findings of the current study are slightly conflicting with the literature. At the same time, it can be seen from the Figure 2 and 3 that the pass/fail rate is slightly affected by the variable age. It can be said that there is a slight contradiction between the findings of the literature and the findings of the current study. This can be explained by the fact that none of the studies reviewed were identical in design, content or context. All studies that have been reviewed measure academic success in the form of GPA whereas this study looks at pass/fail results as academic success. Also this study does not take into account whether a student dropped out or simply did not turn up for an exam, these factors could not be related to age. Further research should be conducted, perhaps in a different design to find out why there is a slight discrepancy between the literature and the findings of this study.

4.0.3 Null Hypothesis B; Prior math grades do not have an influence on academic success.

As before, the hypothesis has been tested on data from the years 2015 and 2016. The first logistical regression yielded a value of 0.0290 and the second logistical regression yielded a value of 0.0418. Both values suggest that the null hypothesis should be rejected.

The major finding from the above is that we can reliably say that the null hypothesis, prior math grades do not have an influence on academic success, should be rejected.

4.0.4 Comparing and contrasting the research findings to the literature for hypothesis B.

First of all it must be noted that within engineering mathematic is a very important subject as it touches on many engineering subjects. This is why math grades are chosen as the variable. The other reason for selecting mathematics over other subjects is that mathematics is a compulsory subject for most levels of education before third level. For this reason, math grades are readily available. Sheridan *et al.* (2020) focuses on younger students and academic success and find a clear relationship between results in mathematics and further academic success. Keane and Gray (2019) conducted a study in Ireland to determine to what extend leaving certificate results and math results at leaving certificate had on engineering and computing. In this study it was found that for computing overall leaving certificate results were a good indicator of academic success whereas maths results at leaving certificate are more important for engineering students. Further papers that have been reviewed all found a strong relationship between prior math results and academic success in engineering (Kitchen 1999; Aliponga 2016; D'Aloisio 2016; Sheridan *et al.* 2020). It is worth noting that not one paper found that prior mathematics results is not a predictor for success. It can be firmly concluded that mathematics is an important subject within engineering. The findings from the current research confirm the findings in the literature.

4.0.5 Null Hypothesis C; Years of relevant work experience does not have an influence on academic success.

The third hypothesis was tested on data from 2015 and 2016. This numerical data was analysed through logistic regression and yielded a *p* value of 0.0325 and 0.0401 respectively. This means that on both occasions the null hypothesis must be rejected.

4.0.6 Comparing and contrasting the research findings to the literature for null hypothesis C.

Two studies have been identified where years of relevant work experience have a strong positive correlation with academic success (Adams and Hancock 2000; Braunstein 2002). Both studies had an MBA programme as a research site and the Adams and Hancock paper concludes that years of relevant work experience has a greater influence on academic success than GMAT results or GPA as undergraduates. Gropper (2007) suggests that GMAT results give students a head start in the first year but this does not affect the overall achievement. This was also confirmed by Kuncel *et al.* (2007). The findings of the current primary research would concur with these findings. It can therefore be concluded that there is a strong correlational relationship between years of relevant work experience and academic success defined as passing or failing the researched programme.

4.1 Additional Findings

This part of the chapter describes some addition findings that are not a direct result of the hypothesis testing. A conflicting additional finding could be that age has a small effect on academic success but years of relevant work experience does have an effect. One would think that the older one gets the more experience one would have and that therefore age and work experience should have a linear correlation. To find out more about this discrepancy, more research would have to be done.

5 Analysis

Introduction

This chapter will describe the analysis of the data. The data originates from two different sources: the first source is personal and demographic information from the institutes CRM system and the second source are 'broad' sheets from exam board meetings containing assessment results. This historical data covers the academic years 2015 and 2016.

First the data will be exposed to a *t* tests to determine if the data has large discrepancies in it. If the data does fluctuate a lot, it might affect the validation of the conclusions drawn from it (Cohen *et al.* 2013). A *t* value of around 0.06 is considered not quite statistically significant, a value around 0.07 or higher is considered statistically not significant and a value smaller than 0.04 is considered statistically significant (Cohen *et al.* 2013).

Secondly, the data will be statistically analysed using logistic regression to determine if the different null hypotheses have to be rejected or not. By doing this, one tests how strong the correlation is between demographic predictors and academic success and provides evidence for accepting or rejecting the hypotheses. The Statistical Package for the Social Sciences (SPSS) used for this is the Stats.Blue. This software tool produces *p* values and graphs that can be used for hypotheses testing. The logistic regression will be employed on both 2015 and 2016 data.

The year 2016 had an extra 16 students added to it because of the popularity of the programme. Adding 16 students to a conventional class could have an effect on the amount of time that a lecturer can spend with individual students and this might result in lower pass rates (Kaddoura *et al.* 2017). However, when the students come to campus to participate in practical's, the students do not work in bigger groups than 16 so it just means that there is one extra group and not a larger class. The theory that is delivered online can be scaled up without any consequences to the amount of time that individual students have in a class.

5.1.0 T-test on data

To ensure consistence and validity of the findings the data has been exposed to a statistical *t* test. This *t* test compares the two means of the data.
The data will be analysed for the three different demographic predictors: age, years of relevant work experience and previous math grades.

5.1.1 T test results of age

When comparing age data from 2015 to data from 2016 the *t* value stands at 0.956 and has no significant statistical value by conventional criteria as mentioned above. This means that the two different data sources do not fluctuate greatly.

5.1.2 T test results of years of relevant work experience

When comparing years of relevant work experience data from 2015 to data from 2016 the *t* value stands at 0.903 and has no significant statistical value by conventional criteria. This means that the two different data sources do not fluctuate significantly.

5.1.3 T test results of previous math grades

When comparing previous math grades data from 2015 and 2016 the *t* value stands at 0.856 and has no significant statistical value by conventional criteria. This means that the two different data sources do not fluctuate significantly.

5.2 Hypothesis testing

The testing of the hypothesis will be done on data from the academic year 2015 and 2016. By testing the hypothesis twice, it can be seen if the study has a high or low level of repeatability.

In this chapter, three null hypotheses will be tested. The first null hypothesis (A); age does not have an influence on academic success. The second null hypothesis (B); years of relevant work experience does not have an influence on academic success. And the third null hypothesis (C); previous math grades do not have an influence on academic success.

5.2.0 Age and academic success; testing null hypothesis A

The mathematical model used for the calculation for 2015 and 2016 is shown in Equation one and calculates a *p* value through logistical regression. After using the 2015 data, data from 2016 will be used to test the hypotheses.

Model: $$P = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x_1)}}$$

Equation 1 Formula that determines P value for hypotheses

Hypothesis A (2015).

> *Age does not have an influence on academic success.*

After inputting the age data and pass/fail data in the Stats.Blue logistic regression calculator the following results were obtained;

Model: $$P = \frac{1}{1 + e^{-(0.4891 + 0.0200 x_1)}}$$

Equation 2 P value for hypothesis A (2015)

Using this mathematical model, a *p* value of 0.6997 was obtained with the corresponding graph as in Figure one.

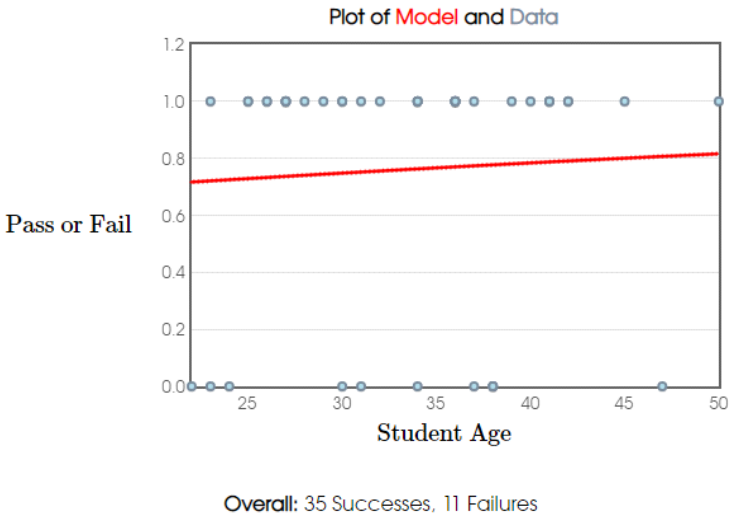


Figure 2-Pass or Fail Related to Student Age (2015)

It can be seen from the graph that as the age of the students increases (x-axes), the probability of a student passing (y-axes) goes up as well but does not have a significant statistical influence. The more horizontal the line, the less strength in the correlation.

From this graph and the corresponding *p* value (significantly higher than 0.05) it can be concluded that age does not have an influence on academic success (Dimitrov 2008).
In other words, the null hypothesis is not rejected

Hypothesis A (2016).

Age does not have an influence on academic success.

After inputting the age data and pass/fail data in the Stats.Blue online logistic regression calculator the following results were obtained;

$$\text{Model:} \quad P = \frac{1}{1 + e^{-(0.0431 + 0.0304 x_1)}}$$

Equation 3-P value for hypothesis A (2016)

Using this mathematical model, a *p* value of 0.4660 was obtained with the corresponding graph as in Figure three.

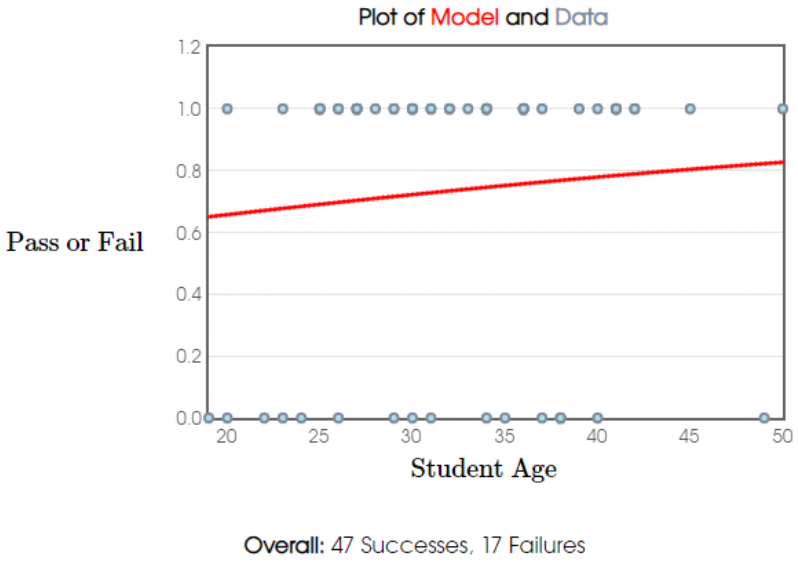


Figure 3--Pass or Fail Related to Student Age (2016)

The *p* value for data set 2016 (p=0.4660) is statistically not very different from the data set from 2015 (p=0.6997). From this it can be concluded that the null hypothesis should not be rejected based on the data set from 2016. Both tests from 2015 and 2016 data yield the same result (do not reject null hypothesis). This part of the study has repeatability.

5.2.1 Years of relevant work experience and academic success; testing null hypothesis B.

The second null hypotheses that will be tested is related to the correlation between how many years a student has been accumulating relevant work experience and academic success. The years of relevant work experience data has been extracted from submitted CVs from applicants. The CVs have been reviewed and relevance has been defined as working in industrial automation in the fields of process control, discrete manufacturing or building controls.

First of all the data set from 2015 will be consulted. The hypothesis is:

Years of Relevant work experience does not influence academic success.

To test this hypothesis for 2015, the data was entered in the Stats.Bleu. calculator. And the findings are presented below.

The *p* value has been calculated as 0.0290. As this *p* value is far below the value of 0.05 we can reject the null hypothesis. The calculations and graphs to support this are shown below in the graph of Figure four.

$$\text{Model:} \quad P = \frac{1}{1 + e^{-(-0.1298+0.2697x_1)}}$$

Equation 4-P value for hypothesis B (2015)

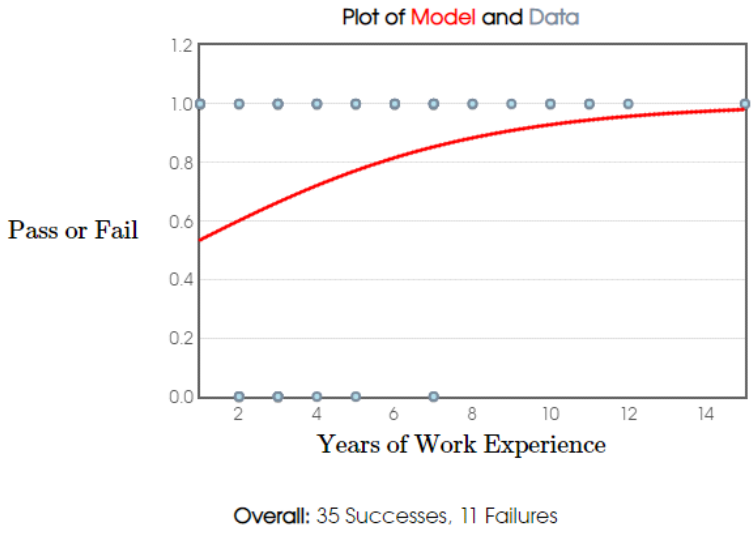


Figure 4-Pass or Fail Related to Years of Relevant Work Experience (2015)

From the graph above it can clearly be seen that as the years of relevant work experience (x-axes) go up the chances of passing the programme (y-axes) go up as well.
It can be said that there is a strong correlation between years of relevant work experience and academic success.

Hypothesis B (2016)

The same statistics are now employed on the data set from 2016. With the following results. The *p* value for 2016 is 0.0418 which suggests rejecting the null hypothesis. This would be the same for the year 2015 with the difference being that the *p* value has gone up but not high enough (0.05) to have a different outcome.
The calculation and graph in Figure five support this statement.

$$\text{Model:} \quad P = \frac{1}{1 + e^{-(0.0211 + 0.2481 x_1)}}$$

Equation 5-P value for hypothesis B (2016)

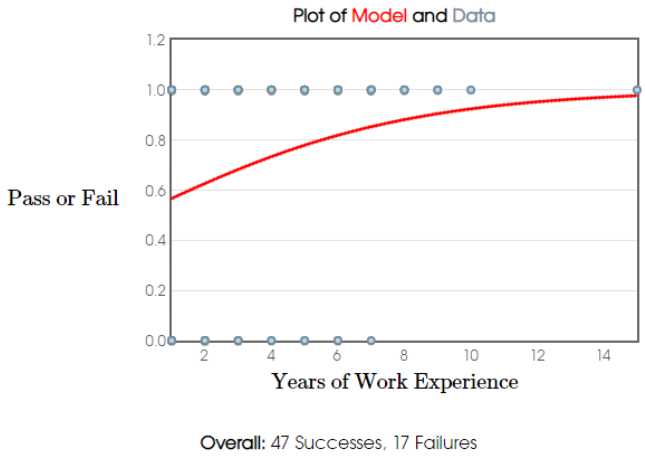


Figure 5-Pass or Fail Related to Years of relevant work experience (2016)

5.2.2 Third hypothesis test. Prior math grades; testing null hypothesis C

Prior grades are defined as math results at leaving cert. Math results have been chosen as all students that apply for the programme have math results as it is a compulsory subject in Ireland and many other countries. The researched programme would rely on mathematics in all the modules. Further to this, typically mathematics would be taught throughout an engineering degree from year one to year 4 and touches on many disciplines in engineering. Mathematics is used in programming, mechanics, engineering physics, electronics/electrics,

control systems, robotics, data communication, instrumentation and pneumatics. For this reason, prior mathematic grades are chosen as it is such an integral part of mechatronic engineering and engineering in general.

To use the prior grades, the marking system needs to be converted from the system where marks such as A1 or B3 are used at a higher or ordinary level to a pure numerical system. This is needed so the data can be entered in the logistical regression model. The leaving cert grading system changed in 2017 but the old system can be used because all the applicant did their leaving cert before 2017. The conversion of marks is shown in the table 5.

Table 5.1-Grades converted to CAO points prior to 2016 (source CAO.ie)

1982-2016 Grade	New points (Higher level)	New points (Ordinary level)
A1	100	56
A2	88	46
B1	88	46
B2	77	37
B3	77	37
C1	66	28
C2	66	28
C3	56	20
D1	56	20
D2	46	12
D3	46	12
E	33	0

None of the applying students have higher level maths on their leaving cert so the scale of the ordinary column will be used. The scale between 0 and 56 has been converted to a scale between 0 and 100. Even though it is not essential to do this, it gives a more conventional way of representing information. The new grades are presented in table 5.2 and will be used in the logistical regression model.

Table 5.1-Grades converted to CAO points post 2016 (Source CAO.ie)

1982-2016 Grade	Points (Ordinary level)	New grades (between 0 and 100)
A1	56	100
A2	46	86.0
B1	46	86.0
B2	37	71.5
B3	37	71.5
C1	28	57.0
C2	28	57.0
C3	20	43.0
D1	20	43.0
D2	12	28.5
D3	12	28.5
E	0	0

Hypothesis testing (data 2015)

Prior math grades are not a reliable predictor of academic success.

Results from hypotheses testing:

$$\text{Model:} \quad P = \frac{1}{1 + e^{-(-1.7249 + 0.0532 x_1)}}$$

Equation 6-P value for hypothesis C (2015)

The *p* value resulting from logistical regression is 0.0143. This value is significantly smaller than 0.05 so we reject the null hypothesis.

The graph in Figure 6 shows the results graphically.

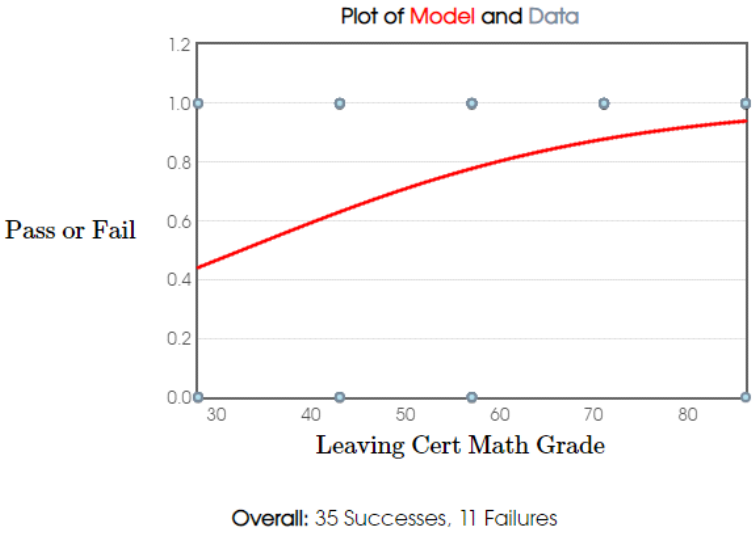


Figure 6-Pass or Fail Related to Prior Math Grade (2015)

Hypothesis testing (data 2016)

To investigate the repeatability of the testing, the hypothesis is tested again on 2016 data.

$$\text{Model:} \quad P = \frac{1}{1 + e^{-(-1.6889 + 0.0493 x_1)}}$$

Equation 7-P value for hypothesis C (2016)

The calculated *p* value stands at 0.0062 which suggest rejecting the null hypothesis and it can therefore be stated that there is a strong correlation between prior maths grades at leaving cert and academic success.

In Figure 7 are the results in a graphic format.

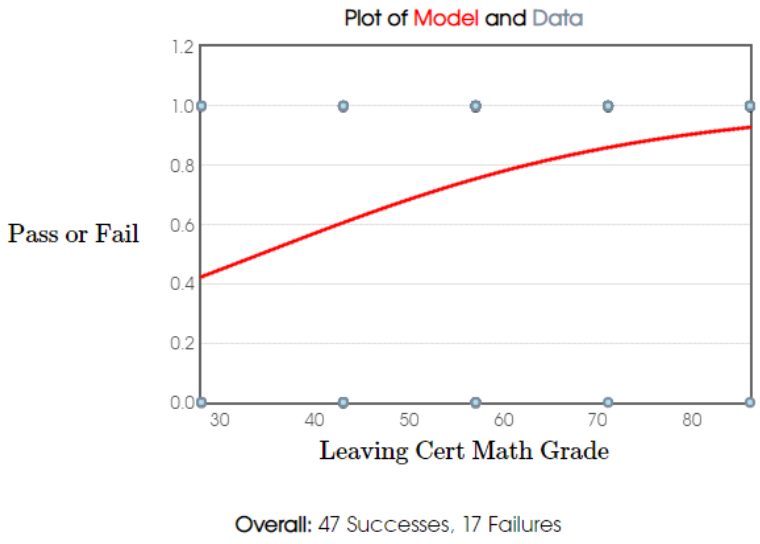


Figure 7-Pass or Fail Related to Prior Math Grade

6.0 Conclusion

The conclusion of this study is directly linked to the research question and the objectives. The conclusions are drawn from the objectives as mentioned in the introductory chapter one.

The first objective was to review the literature and the conclusions from that follows next.

From the literature review it became clear that the term blended learning is slightly ambiguous. The reviewed papers agree that blended learning is a mix between face to face, or traditional teaching, and an online element. How much time needs to be online or face to face is not clearly defined. From this it can be concluded that the definition of blended learning is not uniform. From the literature it also became apparent that some institutes supplement a course with online learning and call it blended learning. This is however not correct. Adding technology to a course would be defined as technology enhanced learning and not blended learning. In blended learning actual face to face time is replaced by online learning. From this it can be concluded that there is a lack of uniformity in the understanding of what blended learning is. The magnitude of this problem is outside the scope of this study. Another conclusion from the literature review is that blended learning is growing fast and that in many cases blended learning gives better results than fully online learning. The need for blended learning is of optimal importance within the context of Covid- 19 with an increased demand for blended online learning. The effect of the Covid-19 on blended learning is however not included in this study as Covid-19 does not relate to the aim, answering the research question.

From the literature review it also became clear that when looking for predictors of success quantitative research methods are more frequently used. Blended online learning in Ireland is defined and delivered in line with international guidelines but not many studies have been conducted on the subject of blended online learning. In an Irish context no studies have been found regarding demographic predictors for success in blended online learning. Most studies on blended online learning are recent (from the last six years) and only one study was identified from 2006 (Donnelly 2006). Carroll (2011) also found that the use of asynchronous delivery is not used to its full potential.

When reviewing literature regarding demographic predictors the following conclusions are drawn: many different demographics have been linked to academic success including, Age,

grit, marital status, gender, nationality or prior grades. However, to answer the research question only specific variables, available to the researcher, could be used. It was concluded that the researcher could only use the variables: age, years of relevant work experience and prior math grades. It was also concluded that prior math grades are a very strong predictor for academic success in engineering.

The second objective was to develop some hypotheses from the literature review and the conclusions from this follow next. After considering the research methods and settling on logistic regression it was concluded that the null hypothesis would be the best option. Out of all the demographic predictors that have been observed it became clear that only some demographic predictors are available for the research. The variables age, years of relevant work experience and prior math grades have been chosen predictors. The reason for this is that these variables are often used in the literature and are available to the researcher through primary data.

The third objective was to test the hypotheses using appropriate research methods to find out if the null hypotheses needed to be rejected or not. From this it was concluded that the null hypothesis A; Age does not have an influence on academic success should not be rejected. The second null hypothesis, B; Years of relevant work experience does not influence academic success. It was concluded that null hypothesis B should be rejected. Null hypothesis C; Prior math grades are not a reliable predictor of academic success, needs to be rejected.

The fourth objective was to compare the findings to the literature and the conclusions from this follow next. The result of the hypotheses testing has been mentioned above and how these findings compare to the literature will is described below. Null hypotheses A; Age does not have an influence on academic success. From the logistical regression graph in Figure 2 and 3 it can be seen that, as the age goes up the pass rate increases as well, and this would be in line with the literature. However, when looking at the calculated *p* value (0.6997 for 2015 and 0.4660 for 2016) it is said that statistically there is no significant correlation between age and academic success. The literature does not always agree with these findings. Abbie-Rose

Imlach *et al.* (2017) finds that age does have an effect but, in this paper, a pure online programme has been studied and according to M. and M. (2014) students with a higher age do better in blended programmes than fully online programmes. It can be concluded from this that age may or may not have an influence on academic success depending on the delivery mode. Another discrepancy between the current study and the aforementioned is that the definition of academic success in the current study is defined as passing or failing whereas in other studies GPA is often mentioned as academic success. Kimeli *et al.* (2019) find a correlation between age and academic success but the cases in this study consists of a narrow age band (60% of cases are between 20 and 24 years of age) whereas the current study has a much broader age band with a higher average age (35 years of age). It can be concluded that age may or may not have an influence on academic success depending on definition of success, age group that is being studied and delivery mode.

Null hypothesis B; years of relevant work experience have no effect on academic success. The null hypothesis in this study has been rejected. Adams and Hancock (2000) agrees with this finding so does M. and M. (2014) and Ibrahim *et al.* (2012). It could be concluded that there is a correlation between years of relevant work experience and academic success. This does suggest that there is causation. This study conclusion is not surprising as some of the subjects on the researched programme are rooted in practical skills which the students might have experienced in through their work.

Null hypothesis C; prior math grades are not a reliable predictor for academic success. This null hypothesis needs to be rejected according to the research. This finding is in agreement with the literature. Depending on the field of study math grades have a greater or lesser effect on academic success (Buechler 2004). For engineering math is a very important subject and is taught throughout the entire programme in many different engineering programmes around the world (Derr *et al.* 2018). It can be concluded that prior math grades are a reliable predictor for academic success.

Finally, the research question must be answered and the conclusions from that follows next.

The research question is to identify demographic predictors for academic success. The researched demographic predictors are: age, years of relevant work experience and prior math grades. The researcher wants to know what these variables are to speed up the reviewing process of applying students. Out of the three identified variables it can be concluded that the

variable age can or cannot be a reliable predictor of success and from Figure 2 and 3 it can be seen that age has some influence on academic success but is not significant. The second variable is years of relevant work experience and this variable is found to have an influence in this study and it is identified as a relevant variable in the literature. The third variable, prior math grades is unmistakably a strong predictor of academic success. This is concluded in the literature and in the current study. This conclusion makes sense as math is taught throughout the programme and also features in its applied form through pneumatics, electrical principles and programming.

The answer to the research question is therefore (in order of relevance): The demographic predictors for academic success on a blended online minor award at third level in an Irish context are: Prior math grades, years of relevant work experience and finally age.

6.1 Recommendations

Blended online learning is increasing in popularity but it does seem that the delivery mode is not always understood or applied correctly. An example of this is a study where a comparison is made between conventional delivery and blended delivery to test effectiveness (Keskin and Yurdugül 2019). It was found that blended online learning did not have an advantage over face to face teaching. This study simply replaced part of the module with an online component without any design. Koohang (2008) states clearly that blended online learning needs to be an integral part of the course design to be successful. In other words blended online learning is not always understood or applied correctly. It would be recommended that educators develop a better understanding of blended learning. This is especially relevant at the moment due to Covid-19. To gauge the magnitude of this issue further research should be conducted to find out what the understanding is of online blended learning among educators.

It would also be recommended that a clear definition is constructed regarding the ratio of the online delivery and the face to face delivery. This matters, because research has shown that a higher proportion of an online component makes academic success for older students more difficult (McCutcheon *et al.* 2018).

As explained in the additional findings chapter, it seems illogical that age does not have a strong correlation with academic success whereas years of relevant work experience does.

Logic would dictate that age and work experience would be have a linear correlation. One would expect an older person to have more years of relevant work experience than a younger person. It could be that the findings from the current research are coincidental or that this current study does not compare like for like with other studies. This could suggest that further research should be done by looking into the data to find out if the older people have more relevant work experience or use more data from other years.

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Appendix A (list of abbreviations)

AISSHE-J	All Ireland Scholarly Higher Education Journal
CPD	Continuing Professional Development
CRM	Customer Relationship Management
ECTS	European Credit Transfer System
GDPR	General Data Protection regulation
GMAT	Graduate Management Admission Test
GPA	Grade Point Average
HEA	Higher Education Authority
ICT	Information and Communication Technology
IoT	Institute of Technology
ILTA	Irish Learning Technology Association
MBA	Masters of Business Administration
MOOC	Massive Open Online Course
NUIG	National University of Ireland Galway
OER	Open Education Resources
QQI	Quality and Qualifications Ireland
RTC	Regional Technical College
SAT	Scholastic Aptitude Test