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Utilising human-robot interaction and gamification principles for enhanced adult learning experience

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Abstract

The pace of traditional teaching methods to deliver new skills to adult learners is slowly being constraint by the need for business to apply these skills in their organisations and the rate of change they are being introduced. Furthermore andragogy principles on their own could not reduce the knowledge to action gap post skills transfer has taken place, leading to more experiential techniques to be explored.

This lead to the intent of the study which was to understand if one could apply the use of gamification and an experiential element, human-robotic interaction(HRI), to andragogy principles to the design of a module to understand if it was possible to reduce the time to transfer knowledge and have learners apply them post the session.

The longitudinal study was done in two phases to understand during the module delivery itself as well as nine months afterwards if the topics selected to be taught the candidates felt they were exposed to and if they had believed they had applied it due to the session itself.

The findings revealed positive outcomes to the study, understanding that these techniques definitely benefitted those going through the developed framework.

Declaration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

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Contents

List of Tables

List of Figures

Chapter 1: Introduction

1.1. Introduction to Research:

This study looked to investigate a different approach to training techniques for adult skills transfer to enable reduced knowledge to retention gap and support new ways of transferring knowledge in a short period of time.

This was important to ensure that business leaders had new ways of approaching knowledge transfer through training to be able to apply new skills as they became available. Unfortunately Lubner (2017) indicated in their research that education in South Africa did not cater for skills demanded by businesses due to traditional approach to knowledge transfer through training. This the World Economic Forum supported by indicating that for South Africa to stay competitive, its leaders had to establish what skill sets were potentially required to ensure the country's competitiveness (World Economic Forum, 2018) especially in an environment that was seen as VUCA which was term used to support this constant change which stood for Volatility, Uncertainty, Complexity, Ambiguity (Bennett & Lemoine, 2014).

This meant that the traditional training methods and learning transfer methodologies needed to be reconsidered to keep up to pace with VUCA (Liebhart & Lorenzo, 2014). This lead to leaders needing to play a strong role in mitigating skills transfer gaps through making the correct decisions that would best fit for both the organisation and its employees and thus to do so they needed to be adaptable and flexible through new ways of introducing skills that were in demand and relevant to the changing environment (Bennett & Lemoine, 2014; Liebhart & Lorenzo, 2014).

Also supporting the need for this investigation was due to the demand for new skills that educational institutions could not provide at the same pace for businesses, and leading to a need for new techniques to shift the rate of knowledge retention versus knowledge transfer (Montebelli, Billing, Lindblom, & Dahlberg, 2017)

Thus it is important to understand two components of a new technique that should be considered, namely; does the technique itself work to apply knowledge transfer successfully during the engagement and does the technique change the knowledge transfer into actual application and action of the content without it being seen as a novelty.

This chapter will explore the base problems the study was trying to address and the reason and its significance in the chapters that follow.

1.2. Background:

There is a need to look at new training methods for adult learners to help them as well as business keep up with the demand of new skills required to stay competitive. Many skills are caused by technology spill over enabling new forms of careers for individuals as well as capabilities for businesses (Sun & Fan, 2017).

This meant that there was a need to consider looking at ways for not only finding a sustainable technique to transfer knowledge but ensure that the method retained the knowledge over a period so that the effort was not wasted and rendered value to both business and individuals. This process was termed Knowledge to Action (Field, Booth, Ilott, & Gerrish, 2014).

Andragogy theory supported adult learning through knowing what the important principles where to consider when training adults, these had to be considered when looking at any new form of technique that would involve adult knowledge transfer and session design. This principles considered past experience, self-directed involvement and direct application of what was learnt in their own environments to ensure relevance of what was being transferred in terms of knowledge (Knowles, 1996).

Research done by Davies, Fidler, & Gorbis (2011) noted that consideration to experiential learning should be given that allowed for collaborative work to solve problems and integrating interdisciplinary skills rather than a focus on one field to achieve future skills development.

Thus to support this Human-Robot Interaction (HRI) was looked at as it was seen as an emerging multi-field of study that covered computer science, engineering and even social sciences using robotics allowing for new ways of thinking and provided little motivation to use when teaching (Young, 2017) and has been used to apply new skills for adoption (Zenk, Crowell, Villano, & Diehl, 2017). Gamification, also known as the "fun theory", was used because it was seen as a set of techniques used to intervene in learning to derive a positive outcome through use of motivation and engagement scenarios (Huang & Soman, 2013). Both these areas have seen cases of successful knowledge transfer and motivation of learner involvement.

The skills leaders to consider to stay relevant and competitive in their environments, post 2020, where the following five namely; complex problem solving, critical thinking, creativity, people management and collaboration (Gray, 2016).

Understanding that these skill will remaining critical for leaders the research aimed to make use of the techniques such as HRI and gamification to design a training activity suitable for educating leaders to utilise these skills.

Thus the research investigates if HRI and gamification can be introduced into a training activitiy to increase the retention of these skills required for the future.

To that extent I have been hired by the Gordon Institute of Business Science (GIBS) to host an executive training programme employing HRI in gamified scenarios which were collaboratively designed by GIBS and myself and have been given consent to engage the candidates to use it as part of the research for this study to understand if these techniques did render sustainable knowledge transfer and retention.

1.3. Problem Statement:

According to Mngomezulu (2017), for businesses to stay competitive in the face of the fourth industrial revolution, they need to find faster ways to transfer relevant skills. The investment into leadership development programmes and similar business education have been relatively high (Johnson, Garrison, Hernez-Broome, Fleenor, & Steed, 2012) with the intent of making sure that the organisations stay competitive but these interventions could not be seen as a once off exercises as continuous learning is critical to ensure potential future skills are maintained as well as to adapt to any new skills as they emerge (Bennett & Lemoine, 2014; Salas, Tannenbaum, Kraiger, & Smith-Jentsch, 2012).

This meant that knowledge transfer through learning interventions were critical to ensure that new skills needed to make better decisions for the the organisation were implemented and actionable. Unfortunately a challenge according to Ward, House, & Hamer (2009) such interventions had gone mostly untested to see if they had indeed effective on the individuals, it was noted though that they did try in 2012 to test if such transfer was possible and provided a basis to build on for future research (Ward, Smith, House, & Hamer, 2012). It was important that the shift in reducing the gap between knowledge transfer and action was necessary to bring

about the changes required within leaders, the longer that gap was in application of the knowledge could risk it not being applied (Knowles, 1996).

Current educational institutions run the risk of not being able to meet the pace of new skills requirements and this needs to be considered in looking for new techniques (Davies, Fidler, & Gorbis, 2011). Therefore an approach for implementing learning transfer that could be applied to new skills in terms of knowledge gained and retained into action needed to be found. This was applicable to both at senior manager level as well as their staff entering and navigating the workplace (Lubner, 2017).

The reason why principles of gamification and human-robot interaction where chosen was that gamification brought in motivational elements into education and drove behavioural change through its usage in designing educational sessions (Huang & Soman, 2013). Human-Robot Interaction(HRI) had been applied to transfer non-technical skills as part of studies done by Young (2017) with the intent of changing students behaviours and supporting this Blain, Ferworn, Li, Tran, & Carter, (2017) used it as part of their multi-disciplinary study to test students that had no exposure to robotics or programming to solve problems in their work environment using HRI thus aligning learning's in a similar way as the requirements that adult learning principles were built on such as problem centred design of learning interventions (Knowles, 1996).

One of the challenges noted of HRI in knowledge transfer interventions, like gamification, the interaction has to be designed correctly with specific expected outcomes. Though the evaluation techniques compared to classic Human-Computer Interaction, which relates the human inputs and engagements with computer systems in their various forms (Hibbeln, Jenkins, Schneider, Valacich, & Weinmann, 2017), has mostly not been tested as it's a relatively new discipline (Montebelli, Billing, Lindblom, & Dahlberg, 2017). However it is noted that HRI would play a large role in the future of skills development required within organisations especially with the demand for those skills by organisations that education institutions cannot provide at the same pace (Montebelli, Billing, Lindblom, & Dahlberg, 2017).

The question that this research sought to answer was could utilisation of human-robot interaction and gamification principles enhance the adult learning experience.
In the process of answering this question, answers would also emerge for the following follow-up questions. These were:

1.3.1. Sub-problem 1:

To understand if it was possible to design a learning intervention using HRI and gamification to teach the five skills of the future.

1.3.2. Sub-problem 2:

If the learning intervention was successful, would there be a retention of the skills through reduction of the knowledge to action gap.

1.4. Purpose of the Study:

The purpose of this study was to establish whether human-robot interaction and gamification principles help adult learners to increase knowledge retention and reduce the knowledge to action gap. This would be used as a motivator designed around andragogy using human-robot Interaction to test if a combination of these principles can make the necessary learning transfer change in a short period of time.

The intent would be to carry out an inductive study to understand if it was possible to educate the candidates on the five future skills (namely; creativity, people management, critical thinking, complex problem solving and collaboration) using these techniques to confirm if one can design a learning intervention that is sustainable in transferring knowledge using gamification and HRI and secondly to do a deductive study to understand if post the application it would render the reduction in the knowledge to action gap and thus a sustained learning transfer using a potentially accelerated learning approach that could be used in future on other topics.

1.5. Research Aims:

The first aim of the research was to explore if it was possible to make use of HRI, gamification and andragogy to design a two hour intervention that could effectively assist the delegates to learn the five future skills. This would be tested by quantitative survey using a five point likert scale post each classroom session to test if they candidates had felt exposure to those skills throughout the session.

Thereafter the second aim of the research was to explore if such an intervention could reduce the knowledge to action gap after a lengthy period of time, we used nine months. This would be done using qualitative semi-structured interviews with a sample of the candidates that had attended the original sessions.

The reason a period later was chosen in this mixed method longitudinal study was to mitigate the risk noted by Hamari, Koivisto, & Sarsa, (2014) noting that experential learning methods like gamification could be seen as a novelty and further in their findings this was seen in quantitive, qualitative and mix method approaches of research to these studies over a period of 6 months and longer. Thus it would be important to ascertain if it was indeed a novelty or if it had rendered the actionable results through the phase two findings.

1.6. Scope of the Study:

The study was broken into two phases as part of a longitudinal study;

The first phase:

This was applied to a GIBS programme that was attended by forty candidates from senior management level. The candidates were taken through a few scenarios that were designed specifically to use gamification and HRI underpinned by Andragogy principles, this is detailed further as part of Chapter 4: Research methods and design. They involved robotics and programming of the robots themselves using the candidates own mobile devices through the different scenarios with the intent of covering the five skills expected to be had by future leaders, namely critical thinking, problem solving, collaboration, people management and creativity.

Figure 1: Robots in Session

To evaluate of the actual technique was successful using the applied theories, the candidates were asked to complete a survey at the end of the session, which they consented to as part of the workshop, to understand through quantitative statistics if they had found they were exposed to those skills and thus proving that the designed technique could in fact transfer skills and if it was something that could be repeated in application of other skills. However as mentioned before this was not the primary objective of the study.

The second phase:

This phase involved returning to candidates after a period of nine months, who consented to be interviewed, to understand if they did in fact adopt and apply any of the five skills since the workshop itself, with the intention to understand if the workshop itself had made them change the way they utilise those skills if they have done so before or if it had enabled them to start applying any of those five skills more consciously. This was done using qualitative interviews supported by thematic coding to link the outcomes to specific themes to support if this phase was a success. This phase was considered the critical part of the study as it would support future application of such framework of theories to enable accelerated knowledge transfer and reduction of the knowledge to action gap.

1.7. Benefits of the Study:

The focus of this study is on adult education and learning acceleration. Some of the potential benefits of this study could see improvements in the areas for the following role players:

The delegates themselves attending such accelerated courses have the opportunity to get more hands on learning and the ability to absorb new skills and potentially apply them in their social environments sooner than other candidates that follow traditional methods. This is keeps them relevant and competitive and have the ability to stay job fit as the environment changes (Davies, Fidler, & Gorbis, 2011).

The training course designers are enabled to change their content to be more exciting and apply theories that make it easier to motivate candidates to actually take up the learning and the curriculums they provide. Also creating potential for regular return of candidates through the usage of reward systems as those provided in gamification (Huang & Soman, 2013).

The facilitators of these sessions gain exposure and quicker feedback on progress of candidates through the session also allowing them to change and shift as the emotions of the candidates change if these curriculums are designed more flexibly which can be done based on the content that needs to be transferred both from an HRI (Montebelli, Billing, Lindblom, & Dahlberg, 2017) as well as a gamification perspective (Marache-Francisco & Brangier, 2013) .

Finally for the corporate education managers themselves, they have the capability to quickly adapt new skills as the organisation changes due to the VUCA environment they face (Bennett & Lemoine, 2014) which forces the organisation to stay competitive and keep its employees and leaders relevant to stay ahead.

1.8. Significance of the Study:

According to Lubner (2017) education in South Africa does not cater for skills demanded by businesses. While it follows that managers should respond by creating an environment conducive for appropriate skills acquisition, it is not always clear how they could do this. This research seeks to establish whether human-robot interaction and gamification could accelerate the process of skilling employees for future fit by reducing the knowledge to action gap in a shorter period of time. For learning departments it gives options to apply continuous learning of new skills to allow relevance to the employees environment (Knowles, 1996) in a much shorter space of time and also enable organisations to benefit sooner from these outputs due to the reduction in the knowledge to action gap..

On a last point it is important to note that the lessons learnt from this study are generalisable and can be modified for other learning approaches with different learning objectives which can aid in future training scenarios not just applicable to the future skill sets noted (Davies, Fidler, & Gorbis, 2011), so that it can be applied to other skills such as programming or basic education components to accelerate and knowledge transfer from younger age groups as well thus allowing for new skills to be developed before the youth reach organisations thus reducing the burden on organisations to bring their employees up to competitive standards.

1.9. Ethical Consideration:

As part of phase one of the module designs and application to GIBS executive training programmes which consent was provided by GIBS, through the programme manager as well as the clients who attended the programmes by signing up to the bigger executive programme itself. The clients, or from herewith forward referred to as "candidates", were part of the INSETA sector from various insurance companies who attended the GIBS executive training programme.

Confidentiality of candidates was part of their application to the training programmes and surveys they completed. Survey's themselves were not mandatory to be completed by the candidates and those that were completed were done in anonymity so no candidates were able to be linked to any of the survey answers.

Ethical clearance was also obtained before any interviews were performed as part of phase two. Confidentially of all participants was kept in the study and only those participants who consented to the process were included.

1.10.   Conclusion:

The rest of the research paper will look at literature pertaining to the principles and constructs that the research is build around under chapter 2. Chapter 3 will look the important questions this study is attempting to answer followed by chapter 4 which will introduce the methodology used to do the research. Chapter 5 and Chapter 6 looks at what data was gathered during the surveys in phase one as well as the phase two interview process and what was the findings out of the results and outcomes of the research questions. Finally chapter 7 will close off the paper by looking at the implications of the study as well as future research opportunities.

Chapter 2: Literature Review

2.1. Introduction to Literature Review:

This section will look at the foundational core for the study, with the goal of setting the context of the research foundations, looking at what is considered part of the scope of the study and supporting the outcomes of what has been done. It will cover contexts by different authors under each of the principles and constructs and also consider them in the context if they are proven and valid (Boote & Beile, 2005).

This helps understand what has been already done and where this study can help build on the current content and support future research.

2.2. Adult Education:

The importance of Adult education stems from the need to continuously improve to ensure survival due to disruption both in economic and technological sense (Coleman, 2017). Further to this it has also been a defining factor in change of salaries earned by those who have lower levels of education versus those with higher tier education behind their names, seeing those with higher tier education earning more than those on the lower tiers (Tamborini, Kim, & Sakamoto, 2015).

Unfortunately it is seen that motivation to learn decreases with age (McCrae,Costa, de Lima, Simões, Ostendorf,Angleitner,Iris,Denis,Gian Vittorio,Chae,Piedmont (1999) and further more so that adult learners prefer to maintain what they know rather than expanding into the unknown in areas that challenges the adult learners perspectives (Chamorro-Premuzic, 2018). Rothes, Lemos, & Gonçalves (2014) found in their research that there where two types of motivations within adult learners, firstly extrinsic motivation which was driven by the need to develop economic, social or professional status while the other is intrinsic motivation which is driven by a desire to learn content that would enable further social engagement. As adults grow in age they perceive less importance to further studies as it does not benefit them (Rothes, Lemos, & Gonçalves, 2014) however as noted earlier it becomes even more important to consider continuous learning and development as it becomes important to both organisations and the adult learners themselves to stay relevant and competitive (Coleman, 2017).

As previously mentioned the investment into leadership and development programmes have been relatively high within organisations (Johnson, Garrison, Hernez-Broome, Fleenor, & Steed, 2012). Countries like the United States spent roughly around $134bn a year on individual training (Salas, Tannenbaum, Kraiger, & Smith-Jentsch, 2012) and $34bn on leadership training (Johnson, Garrison, Hernez-Broome, Fleenor, & Steed, 2012) and this was seen just to stay competitive and keep the best employees within the organisation. Thus it is very important that the correct training is done and costs are not wasted without any tangible or sustainable outputs.

It was important that the shift in reduction of the gap between knowledge transfer and action or decision making was necessary to bring about the changes required within leaders as well as employees within organisations, the longer that gap was the less chance there was for a decision maker to make the correct decision and hence the importance of finding new techniques of applying learning's in a shorter period of time. It was further noted that the demand for new types of skills could not be sustained at the current learning pace that educational institutions provided and would also eventually become a constraint both on business and academia (Montebelli, Billing, Lindblom, & Dahlberg, 2017).

The question comes to mind which skills should organisations consider to look at especially with an VUCA world, this the Institute for the Future, which is an independent, non-profit strategic research group which had been focusing on emerging trends and how they affect the future of careers (Institute for the Future, 2018), have noted six key drivers that are expected to see as big shifts in the world and effecting organisations and would lead into the skills to consider.

These six drivers were Extreme Longevity, which considers human beings potentially living longer due to medical and technological advances; Rise of Smart Machines and Systems which sees the replacement of repetitive tasks by machines through automation as well as humans paired by robots for assistance to increase their capabilities; Computational World, leads to the view of increased access to sensors making the world itself more programmable allowing expansion of technology into a multitude of fields; New Media Ecology, shifting the view of standard text communication to fields focused on cognition and attention where messages are instant to millions of people without filters; Super structured Organisations which sees traditional organisations reaching their limits but interconnected ones with global collaboration and sharing pushing past these boundaries and a Globally Connected World which sees the end of central

structures such as countries such as United States or Europe having political will and power and having it shift to the millions of people through globalisation and knowledge sharing without the need for constraint legacy infrastructures (Davies, Fidler, & Gorbis, 2011).

The implications of this was that education and teaching methods needed to change for organisations to be able to adapt to the new skill sets required to meet these potential changes, it had to be focused on being adaptable with capabilities that can be reused such as critical thinking, analysis and insight which can be used across spectrums, further supported by the rise of creativity also as a skill which was low on the rankings in 2015 and now considered as one of the top five skills required in organisations (World Economic Forum, 2018). Thus the five skills that became apparent as critical for individuals to meet the demand of organisations as well as what organisations had to consider as capabilities within their employees was critical thinking, complex problem solving, creativity, people management and finally collaboration (Gray, 2016).

The first skill, critical thinking allowed individuals to outline proper arguments and analysis through understanding and evaluation of a specific topic (Davies M. , 2013). This was seen as important for businesses to have individuals that had this capability to help drive the organisation forward through critical analysis of their surrounds to make the right decisions at the right time.

The second skill was complex problem solving which was considered extremely important within the context of a VUCA environment as decision makers needed to make decisions quickly to survive in the 21st century. The concept itself was a process of acquiring knowledge of a unknown and ever changing environment and finally finding a way to understand and manage it to achieve specific goals or objectives (Greiff, Wustenberg, Holt, Goldhammer, & Funke, 2013).

Further to this, it was found that application of game based theory such as gamification could help develop this skill set, as complex problem solving generally involved many interconnected scenarios that could be played out to make a specific decision and can be simulated to test this skill (Eseryel, Law, Ifenthaler, Ge, & Miller, 2014).

The third skill was creativity which in itself supported design thinking allowing leaders to change the way they looked at innovation (Calabretta & Kleinsmann, 2017). Business leader education did not always cater for creativity as a skill as it was not seen as a traditional business skill (Baker & Baker, 2012) but organisations while trying to stay competitive and meet the real demands brought about the VUCA environment (Bennett & Lemoine, 2014) required creativity as a critical skill.

The fourth skill was people management which forms the centre of any organisation as leadership through people to get goals achieved was important. People management was done through strategy formulation to innovation of new ideas to take the organisation to the next level (Gresse, 2017). As part of this, leadership went hand in hand with people management and it was seen as how best people could be managed based on their strengths and weaknesses to achieve organisational common goals. This Johnson, Garrison, Hernez-Broome, Fleenor, & Steed (2012) noted that for any training to be successful goal setting needed to be done, this included behaviour change expected by the leaders post their training intervention, hence people management as a skill even played a key role in ensuring continuous learning and training interventions.

The fifth skill was collaboration which was a process of engagement through many forms, such as voice or email as well as other forms of communication. This involved an exchange of views and perspectives between parties to reach consensus on specific topics and meant it was a two-way form of communication and not a supervisory type process (Lindeke & Sieckert, 2005).

That was important to understand that collaboration was used to ensure all parties were aligned and all views were at least voiced and understood to ensure a consolidated approach in reaching an organisations objective.

However it was noted that students leaving school were not well equipped with these five skills as they entered the work environment and this in turn impacted the organisations to be competitive in a local and global landscape due to poor decisions being made that were not properly thought through (Jackson, 2013). Further to this it seemed to be assumed that everyone was generally equipped with these skills and little was done on new entrants into the organisation to encourage learning of such capabilities for success of employment (Davies M. , 2013).

These skills are important to organisations as routine white collar jobs stand the chance of being automated which allows for organisations to operate faster and more efficient (World Economic Forum, 2018). Also through these new skills emerge that have not potentially existed before, creating new options for the workforce, caused by technology spill over (Sun & Fan, 2017). Examples of these are the need to maintain automated robotics in a manufacturing plant or a mine.

 All of these are new types of decisions business leaders need to face and the need to adapt and evolve knowledge transfer of new skills into action has to be done at a faster rate.

Leaders had an play important role in knowledge transfer amongst employees and driving supportive behaviour (Carmeli, Gelbard, & Reiter-Palmon, 2013). This was further explored to show that this could be achieved through leadership by creating positive environment with constructive feedback which would lead to creative problem solving and knowledge sharing internally as well as externally to the organisation (Carmeli, Gelbard, & Reiter-Palmon, 2013).

Thus how could one best design a module that could increase knowledge retention and increase knowledge to action gap while imparting these five skills on leaders to be able to enable them to apply if further in their organisations?

2.3. Andragogy:

Andragogy is defined as "the art and science of the art and science of helping adults learn" (Knowles, 1996). Michael Knowles, considered the father of the andragogy principle, noted that education does not stop at the age of 21 and that traditional methods which have focused on understanding and teaching the known are not applicable as we start to approach the unknown (Knowles, 1996). In his research Knowles (1996) further noted that there are four learning principles that need to be applied to adult learners,

- The First Principle:

The first principle was involvement of learners to define their measurements of outcomes which Johnson, Garrison, Hernez-Broome, Fleenor, & Steed (2012) supported as a critical component for leadership development through goal setting.

- The Second Principle:

The second principle was learner experience through failure as basis of learning, which spoke to the need for constructive feedback during leadership development to ensure development was not lost and lessons learnt could be applied (Carmeli, Gelbard, & Reiter-Palmon, 2013).

- The Third Principle:

The third principle related to relevance directly to learners current life as well as impact on their working environment in terms of applicability this meant that relevance was important to adult learners, as it was referred to as "in the moment" learning according to O'Toole & Essex (2012).

This spoke to goal setting and understanding what VUCA can potentially entail, such as potential future skills that could cause obsolescence of current skill sets of leaders and their employees (Davies, Fidler, & Gorbis, 2011).

- The Fourth Principle:

The fourth principle in andragogy was that the learning had to be problem centred rather than content orientated (Knowles, 1996), this meant that the focus would be on potential business problems in an organisational context rather than a specific content topic itself.

Underpinning these principles were assumptions that Michael Knowles made about the adult learners themselves. The first assumption was Self-Concept, which saw adult learners resisting attempts made by others to impose their will on them such as being taught by another adult and preferring self direction in a learning environment versus that of pedagogy which saw learners following a standardised and organised way of lesson delivery (Knowles, 1996; Taylor & Kroth, 2009).

However it was noted that this was generalisation as there were adult learners who needed a teacher role to help encourage their learning process and this was also carried across by pedagogy teaching principles embedded in teachers as part of classroom education which was applicable regardless if they were teaching children or adults (O'Toole & Essex, 2012).

Using the example of law students to counter this statement, one would need the basis to understand the theory through pedagogical models but the students would need to understand it in practice as well to be able to be sufficient at what they did through learning the lessons of a live environment with its real demands (Taylor & Kroth, 2009).

The second assumption made was that adult learners brought a wealth of experience with them which could be applied in the learning environment, which vastly differed from a pedagogy scenario which assumed that learners brought little experience to the sessions and experience brought mostly related to learning's from textbook or similar material rather than real life scenarios (Knowles, 1996; Taylor & Kroth, 2009).

The third assumption made was readiness to learn that assumed adult learners aspired to improve on their tasks in the roles they played but this was under the basis that they found relevancy the topic they were partaking in, this differed from Pedagogy in the sense that it saw

15

learners experiencing the same learning's at the same equivalent age and was mostly considered to be what society needed them to learn at that point in time, such as all grade R students learning to read and write (Knowles, 1996 ; Taylor & Kroth, 2009).

The fourth assumption noted led to the adult learners orientation to learn which related to the application of knowledge directly rather than postponing it post the learning experience. In Pedagogy this was seen as a process of gaining knowledge related to a subject matter which would be later applicable to a specific environment rather than the present (Knowles, 1996 ; Taylor & Kroth, 2009).

The fifth assumption noted by Michael Knowles was the need to know by adult learners, this was contrary to pedagogy as the learners would first need to be exposed to the learning and understanding why it would be necessary compared to adult learners who undertook a learning for a purpose or reason (Knowles, 1996 ; Taylor & Kroth, 2009).

The sixth assumption was motivation to learn, this was considered an internal motivator regardless of external pressure that had been created. Motivation in andragogy plays a further role if you have two individuals with the same background and education and they are asked to do the same thing the motivated individual would "surpass the unmotivated person in performance and outcome"(Knowles, 1996 ; Sogunro, 2015 ;Taylor & Kroth, 2009).

This does not mean pedagogy principles are only based on teaching children as they are more focused around subject and teacher centred approaches to learning with reward and punishment motivations (Ozuah, 2005). This meant rather that compared to pedagogy, adult learners through andragogy principles moved from the stage of dependency towards self-directed learning (Ozuah, 2005) which supported the process of continuous learning and knowledge transfer.

It is however noted by critics that Michael Knowles learning's could be considered very western and only applicable to western mindset or countries. Further to this it does not consider culture specific methods of knowledge transfer and potentially could not work in all environments (Roberson, 2002). Further to this Merriam (2001) found in their research that there were some criticisms to andragogy in terms of it being a theory and that it was more focused on being a set of assumptions or a model that could be applied to certain situations.

However again referring the to the research done by Taylor & Kroth (2009) both principles could be applied to achieve an outcome by combining a theory basis focused on subject matter that then led into practical application using andragogical principles to achieve a positive outcome.

This research had chosen to use three of the four principles as part of the study and the design of the consented GIBS workshop module for phase 1, these were Learn through Failure, Relevance to Learners environment and Problem Centred approach. However on their own it would not be enough to be able to do knowledge transfer and reduction of the knowledge to action gap as it was noted that traditional interventions (Davies, Fidler, & Gorbis, 2011) had not been as successful and motivation was one of the key elements that had to be considered (Tamborini, Kim, & Sakamoto, 2015).

Two areas could assist in providing motivation to adult learners to ensure that they would stay involved in the learning process and potentially seek to return for further learning.
The first was gamification, it was called the "Fun Theory" according to Huang & Soman (2013) who had researched gamification in education. It had a set of techniques used to intervene to derive a positive outcome through use of motivation and engagement based on game design mechanics and elements (Roth, Schneckenberg, & Tsai, 2015). It was also not to be confused as an actual game as it was a form of blended learning that involved motivational theory into its game mechanics (Wilson, Calongne, & Henderson, 2015).

The second was Human-Robot Interaction (HRI), the reason for this was that robots through HRI are much more accepted than other technologies due to the nature of humans treating it as if they have human attributes. This helps aid the use of technology versus other platforms to help with experiential knowledge transfer techniques and provides little motivation to start using it (Young, 2017). Zenk, Crowell, Villano, & Diehl (2017) tested it in their research by introducing robotics to young students with no technical background to see if they would adopt a skill, interest at the start was a problem as first perceptions around the robot was that it was more meant as a toy rather than something that could be used for career development however the non-technical nature brought non-conventional approaches to use of the robot educational process and new insights, adoption in the end was successful and thus potential of using it as part of our research became viable.

2.4. Gamification:

Gamification is defined as the usage of game designed elements that are used in a non-game type context (Erenli, 2013). The theory consists for three main principles called the MDE framework or elaborated the mechanics, dynamics and emotions framework (Robson, Plangger, Kietzmann, & McCarthy, 2015).

- First Principle of Gamification - Mechanics:

The first principle of mechanics relates to how the gamified scenarios are put together and what content needs to be translated with outcomes and goals (Robson, Plangger, Kietzmann, & McCarthy, 2015).

As part Huang & Soman (2013) research, they had designed five steps to put together a gamification approach for education and the first principle was covered as part of their first two steps.

Step one, understanding the Target Audience and the Context, this related to the ability to understand ones audience as well as the context of the learning they needed to be exposed to (Huang & Soman, 2013). Else gamification would not be efficient in its delivery (Marache-Francisco & Brangier, 2013). This aligned to Knowles (1996) third andragogy principle of relevance to learners' environment which was considered an important driver for adults to take on learning (O'Toole & Essex, 2012).

Step two, Defining Learning Objectives, this helped the delivery of the expected outcomes, also relating to contexts such as behaviour based training requirements which could require more concentration versus an alternative requirement (Huang & Soman, 2013). This spoke to one of the principles of andragogy which related to the need to have benefits and meaningfulness for its learners with positive consequences (Knowles, 1996).

- Second Principle of Gamification - Dynamics:

Dynamics as a gamification principle looks at how the candidates going through the process of gamification interact with each other and how their strategies change (Robson, Plangger, Kietzmann, & McCarthy, 2015).

Freeman & Freeman (2013) noted as part of their research that this principle allowed learners to be actively engaged and also allowed them to independently solve problems through reward

structures embedded into the learning processes (Freeman & Freeman, 2013). This helped reinforce the ability to drive knowledge transfer using motivation and engagements that was a pre-requisite in adult learning (Sogunro, 2015).

This further formed part of step three and four of gamification design (Huang & Soman, 2013).

Step three, Structuring the Experience, this related to how the experience needed to be broken up in parts or stages to meet specific learning objectives as well as ensuring it gave the learners a more perceived manageable scope to achieve. This also included components of freedom of choice allowing learner to select their own path to find a conclusion and also prevent the perception of a bad experience (Marache-Francisco & Brangier, 2013). This was supported by the assumptions made around andragogy which saw adult learners learning through self directed approach putting them in control of the exercise (Taylor & Kroth, 2009).

Step four, Identifying Resources, at this point the stages or parts could be reviewed individually and understood if they could be gamified at all. These included measurable as well as clear rules and feedback. As part of these components of intent of the scenario; the situation that is being faced (motivators); the tasks that need to be completed to reach the objectives and the users themselves would be considered for each stage defined. (Marache-Francisco & Brangier, 2013)

- Third Principle of Gamification - Emotions:

This principle considers the intent to evoke emotional states of the learners going through the gamification process, not only due to pragmatism of the process but also due to the fun factor that gamification intended to derive out of the learners themselves (Robson, Plangger, Kietzmann, & McCarthy, 2015).

This fell into the final step of Huang & Soman (2013) design for gamificaion experience. Step five, Applying Gamification Elements, which looked at the two core elements of gamification that could be applied, namely, self-element, objectives that learners could complete on their own to achieve outcomes such as points, and social-element, this brought in team dynamics by introducing competitive or co-operative components and something such as a leader board to track performance (Huang & Soman, 2013).

Ibanez, Di-Serio, & Delgado-Kloos (2014) found in their design that creating a competitive environment in designing a leaderboard which required students to earn points and badges

visible to all other members for completing assignments it drove up participation. The final results found in the case showed the students continued past the maximum points earned and further went on to learn about other topics that were not part of the core curriculum (Ibanez, Di-Serio, & Delgado-Kloos, 2014). This was also done Domínguez,Saenz-de-Navarrete,de-Marcos,Fernández-Sanz, Pagés,Martínez-Herráiz (2013) in their research using the Blackboard system to encourage student participation which rendered the same results with increased participation amongst participants through competitive behaviour.

Through competitive behaviour in gamification it created the area of failure against one's peers, but it did align to Knowles (1996) second principle in andragogy around failure as a means to learning through continuous learning (Carmeli, Gelbard, & Reiter-Palmon, 2013) and support intrinsic motivation within candidates (Rothes, Lemos, & Gonçalves, 2014).

Hamari, Koivisto, & Sarsa (2014) had done further studies into gamification to understand what the pitfalls could be, one of these was the negative impact caused by increased competition due to competitive nature caused by using the social-element of gamification. Another was the difficulty in terms of task evaluation (Hamari, Koivisto, & Sarsa, 2014). A further criticism of gamification was that people would use a stock approach in designing course content using badges, points, rewards and which ran the risk of not delivering any value (Seaborn & Fels, 2015).

Hamari, Koivisto, & Sarsa (2014) further researched to see if gamification actual did work and had come to the conclusion that was the case but it had to be considered carefully as to the expected outcomes and measurable benefits post implementation else the success could be short lived. Thus design of the gamification and its intended outcomes had to be done correctly This would be critical in terms of business leader development to close the gap between knowledge transfer and action, if done incorrectly the results would not be as expected and costs will have been wasted (Johnson, Garrison, Hernez-Broome, Fleenor, & Steed, 2012).

Johnson, Garrison, Hernez-Broome, Fleenor, & Steed (2012) in their research found that goal setting was important as part of corporate learning but to ensure learning was done, motivation had to be one of the major elements with candidates to ensure that knowledge transfer occurred. Deloitte Leadership Academy found that in 2011 71% of its employees were not actively engaged in their training interventions which lead to expenditure waste (Huang & Soman, 2013).

They chose a twelve month gamification programme to drive up motivation in executives and this paid off with an increase of 40% in daily visits to their digital academy as well as 37% increase in return users showing that using gamification at a corporate level could render a change in motivation to learn (Huang & Soman, 2013) creating a stickiness factor in the learning process that was required to ensure continuous learning did occur and was not a once of exercise as demanded by the organisation.

Looking at the case itself, the application of andragogy could be seen in a few principles being applied to the executive programme, the first principle was the involvement of learners to apply their own learning pace and measurements, we also saw the use of the third principle relating to relevance to the learners working environment and career growth (Knowles, 1996). This further supported by the assumptions made around andragogy that adult learners would follow a self-concept approach to learning rather than looking at being told what to be taught and aspire to grow in the tasks and social role contexts (Taylor & Kroth, 2009).

Nelson (2012) found in their research that there was a link to increased employee performance using gamification as part of a new learning method that aimed to pull on factors such as self-expression that had not been done before as part of traditional learning methods in a work place environment. Gamification had also found its way into change management (Azadegan & Riedel, 2012) to assist with adoption through motivation, which was important to help sustain any knowledge transfer that was done through a learning intervention.

Roth, Schneckenberg, & Tsai (2015) found that gamification supported innovation through motivation, they noted one case where action research was used with a group through game-based scenarios that allowed them to relook at their current business models to find new business opportunities. In another instance they found that the Finnish National Library reduced its workload by distributing it across a challenge with a set of problems to 55,000 players on an online game who did the work for free just by being motivated to complete those challenges (Roth, Schneckenberg, & Tsai, 2015).

Gamification was seen to drive up participation with team work activities and not only those related to individual performance, especially with cases that required involvement of collaborative activities (Wilson, Calongne, & Henderson, 2015).
Through their research, Wilson, Calongne, & Henderson (2015) had found substantial increase in participation in their study which focused on user adoption as part of a final year project at an academic institution. By designing a gamification approach to the project they saw increased

participation of up to 49% purely on the basis of teams needing to solve problems collectively to gain reward (Wilson, Calongne, & Henderson, 2015). This aligned to andragogy in terms of the principles of problem centred design as well as relevance to the learner's environment (Knowles, 1996).

Gamification in all these cases indicates that it created participation and further interest by participating members. It also drove further learning through rewards if the systems allowed it but did not necessarily create better learning of content on its own compared to traditional methods of learning and would need to be complemented with other techniques (Domínguez, et al., 2013). It also strongly aligned with the principles and assumptions provided through andragogy as supported in each of the cases as well as the design steps of gamification (Huang & Soman, 2013).

Finally another element had to be considered to support both andragogy and gamification to ensure knowledge transfer and reduction in the knowledge to action gap.

2.5. Human-robot interaction for Learning:

Human-computer interaction (HCI) related the human inputs and engagements with computer systems in their various forms. This could specifically be used to bring about emotion during the engagement both from a positive or a negative perspective dependent on how the engagement had been setup (Hibbeln, Jenkins, Schneider, Valacich, & Weinmann, 2017).

This had evolved over the years into separate fields including human-robot interaction(HRI) which was a new to the area of research with many sources of teaching resources (Young, 2017) which in principle was the same as HCI but had been used to solve real world problems as part of learning exercises combined with theory to create multidisciplinary approach (Blain, Ferworn, Li, Tran, & Carter, 2017). It is further noted that it was difficult to create a training intervention combining both technology and people (Blain, Ferworn, Li, Tran, & Carter, 2017). However R-learning (or robot learning) which was a component of human robotic interaction looked at robot aided learning and indicated that all engagements through this process, whether a single session or multiple sessions had produced meaningful results in skills transfer as well as improving motivation to learn. However this had mostly been done on a pedagogical level and also through language skill set transfers (Han, 2010).

Alternative approaches had also been applied to the users of HRI in education to help with knowledge transfer for skill sets. A study done in Japan teaching children at a young age a new language, in this case it was English verbs, was successfully knowledge transferred through the students teaching the robot directly (Tanaka & Matsuzoe, 2012). This indicated self-directed learning carrying the learning process forward (Knowles, 1996) as one of the underlying assumptions of andragogy teaching methods. It is also understood that gamified scenario based learning also acted as a motivator (Huang & Soman, 2013) as in the case with the children following specific scenarios to achieve the goal of teaching the robot.

This allowed for scenarios in adults to be generated that involved learn by doing or engagement with a robot to knowledge transfer a skill. In one instance a study was done to assist drama students through knowledge transfer using HRI, which helps prove the possibilities of teaching non-technical skills through such an approach (Bravo, González, & González, 2017).

One of the cases of HRI looked at a real life problem centred approach to its design, The problem itself originated from Egypt at archaeological dig sites that where being looted to access underground tombs. The proposal was that students at Ryerson University in Toronto apply a practical solution to this problem as part of their exam. (Blain, Ferworn, Li, Tran, & Carter, 2017).What makes this interesting is that the students themselves came from various disciplines and where not given a set of tools to build their robot only a guide of what it had to do in terms of an outcome. This left students making their solutions out of anything they could find to achieve the goal of making a robot that they would need to remotely operate to explore a known dig site called the "BUSA dig" which they would need to map out the site and work as a multidisciplinary team (Blain, Ferworn, Li, Tran, & Carter, 2017).

It is clear that the application of gamification principles, such as motivators and competition to meet a goal (Huang & Soman, 2013), as well as andragogy principles looking at a problem centred approach and using real life context to the problem itself (Taylor & Kroth, 2009) had been applied without noting it to reach the learning objectives required successfully.

Another study, one with the psychology department of University of Notre Dame done by Zenk, Crowell, Villano, & Diehl (2017), looked at two different initiatives to test if they could transfer skills using Human-Robot Interaction. Though the difference with this case was to look at unconventional students, one group being from humanities social sciences and another from non-engineering backgrounds included some with autism.

The students from the first group had noted at the end of their exposure and training that they wanted to learn more and were more motivated to do so, what was also interesting to note was that students with autism had less social anxiety as well (Zenk, Crowell, Villano, & Diehl, 2017). The second group of students found that they felt more comfortable with the technical details of what they had to do to generate the outcomes and not worrying about what made up the robot. This indicated that non-engineering students found themselves more interested in the field of robotics even though it was not their area of interest before starting the initiative (Zenk, Crowell, Villano, & Diehl, 2017).

This helped us understand that it was possible to influence non-engineering participants to appreciate the field of robotics using HRI and also change some aspects of individuals using this field, such as the example of the autistic students. This also supported the assumptions noted in andragogy that there is a motivation to learn by creating a need to want to do so though self-concept (Knowles, 1996).

One of the challenges noted of HRI in knowledge transfer interventions, like gamification, the interaction had to be designed correctly with specific expected outcomes. Though the evaluation techniques compared to classic HCI had mostly not been tested as it was relatively new discipline (Montebelli, Billing, Lindblom, & Dahlberg, 2017). However it was noted that HRI would play a large role in the future of skills required within organisations especially with the demand for those skills by organisations that education institutions could not provide at the same pace (Montebelli, Billing, Lindblom, & Dahlberg, 2017).

The various case studies that have been covered indicated a few areas of learning that could be considered using Human-Robot Interaction (HRI) as part of education, firstly that using HRI could be used to influence the motivational state of a participant based on how the scenarios are planned as part of the session being provided (Hibbeln, Jenkins, Schneider, Valacich, & Weinmann, 2017). This was supported by gamification to some extent in the earlier and later cases indicating that the principles could be combined to achieve a positive outcome such as the BUSA Dig case (Blain, Ferworn, Li, Tran, & Carter, 2017). This was also is supported by andragogy assumptions using motivation to drive self-concept or self directed learning to achieve a goal (Huang & Soman, 2013; Knowles, 1996).

Secondly, because of the practicality of HRI it was possible to create real-life scenarios that could be used to test outputs of learning's and this could be done using multi-disciplinary teams

and not just pure technical resources, allowing subject matter experts to bring robotics into their field of study to solve a problem that is specific to them (Zenk, Crowell, Villano, & Diehl, 2017). This aligned into andragogy principles of problem centred and topic relevance to the adult learners (Knowles, 1996), as well as increasing the urge to learn what was being presented and having it reinforced by HRI to deliver it quicker (Knowles, 1996).

We also found that using HRI changed participants perceptions of the field of robotics which was considered not something they would be normally interested in as it was perceived as too technical but in turn going through the scenarios had changed that perception and that the process and had provided instant feedback to the participants rather than waiting for an outcome of their actions and learning's (Zenk, Crowell, Villano, & Diehl, 2017). Gamification was also seen applied here by building out scenarios with motivators to each goals as well as supporting one of the assumptions raised by Michael Knowles that adult learners need constructive feedback to drive their need to learn (Huang & Soman, 2013; Knowles, 1996).

Finally it had been uncovered that in the case using HRI through practical application by teaching the robot itself that the learning transfer was much higher and sustainable over a period of a few weeks versus participants who were put through the same learning without the option of an HRI engagement (Tanaka & Matsuzoe, 2012). This helped support andragogy as well with real-life application being presented to the learner as they are studying rather than leaving the session and still waiting to apply physically what they had learnt and this was also considered as one of the assumptions behind andragogy (Knowles, 1996).

HRI had strong compatibility to support both Andragogy as well as Gamification in application of a study to look at knowledge transfer as well as reduction of the knowledge to action gap. This would also help support research into the area of HRI as gamification had not be applied to extensively to this field versus other online technology platforms (Liu, Santhanam, & Webster, 2017).

2.5. Conclusion of Literature Review:

This research thus aimed to use principles of gamification and HRI in adult learners supported by andragogy principles to understand if it was possible transfer the five skills as noted as potential future requirements for business leaders. It is important to note that the skills themselves are less important but the focus of the study is to understand if these skills can be

designed into a module that can render the knowledge transfer and if those skills would be actionable post the module itself. This would be done through two phases.

Phase one would consider an inductive process to design a module using andragogy principles supported by gamification scenarios using HRI to teach the five skills, namely, collaboration, critical thinking, complex problem solving, people management and creativity (Gray, 2016). It needs to be noted that consent had been provided by GIBS to design such a module as part of the business I do for GIBS. The intent would be to use a survey with a likert scale to understand if the module itself had rendered its purpose and candidates, who consented through attendance of the module and supported by anonymity, noted that they believed knowledge transfer had occurred of those five skills and the module met its objectives. This would allow the study to understand that the design was successfully implemented.

Phase two would consider a deductive process to unpack if the skills transferred through phase one's implementation had allowed for a reduced knowledge to action gap. If no skills were found to be transferred the session itself could be considered a novelty, which is a risk raised around HRI educational interventions (Hamari, Koivisto, & Sarsa, 2014), rather than allowing sustainable transfer of knowledge. However if it is successful it would help identify possible alternatives to learning approaches that would help accelerate knowledge transfer as well as the reduction in knowledge to action gap.

The design of the study, the findings as well as conclusions to the results would be reviewed in more detail in the chapters to follow.

Chapter 3: Research Questions

3.1. Research Questions: Introduction

The purpose of this research was a two phases longitudinal study looking to understand if we could as part of phase one design a module through the use of andragogy principles with the use of gamification and HRI theories. This would be used for knowledge transfer of five skills considered important for the future, collaboration, critical thinking, complex problem solving, people management and creativity (Gray, 2016).

The second phase of the longitudinal study, looked at approaching candidates nine months after the module to understand if any of the five skills where sustained.

The basis of these phases led to the following research questions that needed to be answered as part of this study:

3.1.1. Research question 1

Can one design a module using andragogy principles, gamification and HRI to teach the skills required for the future?

This research question was directly linked to phase one's outcomes to understand would the designed module deliver the necessary knowledge transfer of the five skills in a short period of time, in this case being just one workshop. If so, it would prove that one could use such a design technique to apply knowledge in a shorter period of time.

3.1.2. Research question 2

Owing to the module designed in phase one being successful would it enable retention of the skills that were transferred?

This research question was directly linked to the outcomes of phase two with the intent of understanding if research question one had been proven to be successful in its implementation would we see the necessary adoption of the skills in the candidates and would we understand what themes would have supported the outcomes of successful retention of those skills.

The next chapter goes through the design of the approach to this research to be able to have answered these two questions as well as the what methods were used to understand the interpretation of the results acquired which is followed in chapter 5 leading into final discussion and conclusion of the results in chapters 6 and 7.

Chapter 4: Research Methodology

4.1. Introduction to Research methodology:

As noted earlier, my company works with HRI in applying courses to students, such as teaching adults to programme robots. With the consent and support of GIBS we looked at developing an HRI intervention using gamification and andragogy principles in delivering a workshop to adult learners as part of one of the GIBS executive training programmes being delivered. This was done to see if we could apply the five skills potentially required by candidates for being future fit.

To understand if such a technique would render future value as a framework for education we had to see if we, firstly could test if the workshop intervention was successful and not seen a a fun teambuilding exercise as a filler in the GIBS programme and secondly understand if the skills themselves were sustainably retained post the workshop.

This required a longitudinal study using mixed method, though the intent of the mixed method was purely for the purposes of test the basis of phase one if it was successful for us to move onto the more important part being phase two which considered the sustainability of the whole framework. Thus considering the two phases it was approached as follows:

Phase One:

The session was held using the scenarios setup in a gamification format using HRI underpinned with Andragogy principles, it took place over the course of an hour and half for the whole session to be completed, the design is highlighted in detail under research design section of this chapter. A survey was provided post the workshop for the purposes of inductive analysis using a quantitative likert scale and the outcomes of the survey would indicate if indeed the candidates had felt that they had been exposed and tested on these future skills (Bidshahri, 2017).

Phase Two:

This led to the next phase of the longitudinal study which followed nine months after a workshop hosted by the GIBS programme with intent to do qualitative interviews through an deductive reasoning approach with these individuals. This would allow for the ability to interview the candidates, with consent, to see if there was a shift from knowledge to action through probing questions to derive a empirically tested paradigm using a qualitative approach. This allowed for

understanding if the method of knowledge transfer could be used for future executive education initiatives.

A similar study was done in terms of knowledge transfer and translation using a mixed method in a real life scenario by House, & Hamer, Smith, Ward, (2012) but this was only done using qualitative interviews and quantitative surveys through engagements of a placed knowledge broker. Further to this if it had been a novelty, as raised as a risk by Hamari, Koivisto, & Sarsa (2014), the findings in phase two would highlight this a few months later especially through opening questions related to a reflection on the phase one sessions by the sample candidates.

4.2. Research design:
4.2.1. Phase One Design:

The design followed the outlines as provided by the steps Huang & Soman (2013) in terms of gamification design. The actual scenarios would be those I developed as part of my business for educating adults to programme robots but they were linked to the gamified scenarios as well as andragogy principles with the underlying skills for the future. It needs to be noted that World Economic Forum (2018) provided for fourteen skills in order of importance which where applied to the scenarios however for the interest of this study we only considered the top five to be important test if the method would create sustainable knowledge transfer as well as the retention. The steps of the design as follows:

Step 1: Understanding the Target Audience and the Context (Huang & Soman, 2013):

There would be planned classroom sessions involving members of the insurance sector from various companies. They would have representation of both genders as well as different age groups.

Step 2: Defining Learning Objectives (Huang & Soman, 2013):
Outcomes were focused on testing perceived future skills (World Economic Forum, 2018), by setting up scenarios that would test those skill sets. Doing so would make the exercise more meaningful and relating it back to context of the classroom discussion rather than just a novelty. This had to specifically take them out of their comfort zone using human-robot Interaction. This was also done as a pre-session exercise to attempt to remove any novelty concepts out of the exercise (Han, 2010). This also help create problem centred scenarios for the learners to complete supporting andragogy through its design (Knowles, 1996).

Step 3: Structuring the Experience (Huang & Soman, 2013):

Introduction was done relating to the future of where skills were going, and then followed up by a video clip relating to how far technology had advanced, specific reference done to University of Florida's Brain Drone Racing (Brain Drone Race, 2017) using Human Computer Interaction with drones and Brain-Computer Interfaces (BCI) which is the utilisation of brain waves to control external elements (Rouse, 2018). This was followed by an explanation of what the class would be taken through and how to programme their own robot with their own mobile device or tablet they had with them. Programming language that was used was based off of "Scratch 2.0" which is Lego's open source coding platform. This helped provide relevance to how the world and their lives was evolving and why the choice of using robots as part of the course content supporting the andragogy principle of relevance to learner. (Knowles, 1996).

The Scenarios were be broken up into the following stages, namely:
    a. Introduction and Setup of their smart device or tablet.
    b. First steps of programming movement of the robot
    c. Programming first sensor (distance detection) and playing a sound based on output.
    d. Programming using the same scenario in "step c" just with enabling "repeat" function to enable the robot to loop the scenario without intervention.
    e. Final step in programming involved using the smart device or tablet's motion to change the colours of the lights on the robot.
    f. A complex scenario involving everything learnt in the previous steps with a 20 minute timer and competition to see which team could solve it first. They were provided with previous scenarios answers to help as well as tips on which coding blocks would be used.
    g. Final challenge was to use the movement of the robot to allow each team to nominate one member to race against the other teams using programming they learnt to move the robot from one point and back and the winner being the first one to cross the line and turning the robots lights on.

All scenarios would be supported by 2 facilitators, one presenting which would be myself and one supporting the class which would be fulfilled by Dr. Jeff Chen. All scenarios also had the engagement of facilitators to support any questions during any exercise regardless if it was part of any of the challenges or not.

Step 4: Identifying Resources (Huang & Soman, 2013):

Each Scenario needed to have a measurable output that brought some form of motivator to the teams and individuals. These were tested by the facilitators after each scenario with each team to ensure that they had successfully achieved the outcomes provided by each scenario. This helped test if these were in fact gamified scenarios or not.

Referring to Step 3, the following motivators were identified as part of the designed exercise:

Table 1: Scenario Motivators

Scenario	Description	Motivator
a.	Installation of Software	Able to participate in classroom exercises
b.	First Programming – Robot movement	Robot moves based on sequence programmed by user
c.	Programming first sensor	Robot plays a sound as soon as facilitator puts hand in front of it. But this only occurs once you run the program.
d.	Learning Loop Function	Robot plays a sound as soon as facilitator puts hand in front of it. This occurs repeatedly.
e.	Learning how to program mobile device/tablet to effect robot	When learner tilts their smart device or tablet left the colours change to one colour, if they tilt it right it changes to another colour. If neither of these conditions are met the lights turn off.
f.	First Challenge – Puzzle	Movement, light and sound is generated from the robot based on a combination of above scenarios based on the puzzle the facilitator proposes. Any steps can be taken to get to these outcomes. Further motivator is actual code is displayed it its raw form (similar to Java & C#) which they developed using just the device in their hands.
g.	Final Challenge – Program Race	Robot moves based on the programmed steps, robot light comes on once programmed as last step. There is a

		winner but all are praised for achieving end result.

Step 5: Applying Gamification Elements (Huang & Soman, 2013):

Core elements of gamification had been applied. The self-element was associated with allowing learners to experiment and play with the programming, during and post each scenario which was be allowed. The social-element was also be applied by creating a competitive team versus team environments. These were tested as part of the last two challenges; both which had a "which team gets there first" element.

Supporting the link of these to future skills (World Economic Forum, 2018) the exercises would be associated as follows:

Table 2: Scenario Skills Link

No	Skills 2020	Description of Skill	Scenario Associated
1	Complex Problem Solving	Ability to solve problems that do not have clear goals, solution paths, expected solutions or all noted elements.	F,G
2	Critical Thinking	Ability to be able to draw reasonable conclusions from a set of information and discriminate between useful and less useful details for solving a problem or making a decision.	F,G
3	Creativity	Ability to use imagination or create original ideas	C-G
4	People Management	Ability to lead, motivate, train, inspire, and encourage others	F,G
5	Collaborating with Others	Ability to synchronise and integrate activities, responsibilities, and command and control structures to ensure that resources are used most efficiently in pursuit of the specified objectives	C-G

6	Emotional Intelligence	Ability to understand other people, what motivates them and how to work cooperatively with them	C-G
7	Judgement and Decision Making	Ability, capacity, or faculty to make considered and effective decisions, come to sensible conclusions, perceive and distinguish relationships, understand situations, and form objective opinions especially in matters that affect action or output.	F,G
8	Negotiation	Ability to settle differences. It is a process by which compromise or agreement is reached while avoiding argument and dispute.	F,G
9	Cognitive Flexibility	Mental ability to switch between thinking about two different concepts, and to think about multiple concepts simultaneously.	C-G
10	Fear of Failure	When we allow fear to stop us doing the things that can move us forward to achieve our goals	C-G
11	Leading with Influence	Ability to cooperate rather than using top down authority	F,G
12	Agility and Adaptability	Ability to constantly re-learn to adapt to fast moving/changing environment	F,G
13	Good Communication	Ability to communicating clearly, which is key for the Knowledge Economy	C-G
14	Curiosity and Imagination	Ability to be Inquisitive and creative	C-G

The final design step helped assist with the application of failure through learning by allowing competitive behaviour but throughout the different scenarios this component of andragogy was used seeing candidates not getting something right and needing to try again in order to proceed (Knowles, 1996).

At the end of the classroom session the candidates were asked to complete an anonymous survey using a likert scale indicating if they had felt that they had been exposed to the skills noted in Table 2.

4.2.2. Phase Two Design:

Follow up after 9 months to evaluate the knowledge conversion to action:

This involved semi structured telephonic interviews with respondents to understand if their perceptions had indeed changed and this was not just seen as a novelty (Hamari, Koivisto, & Sarsa, 2014). The reason for the semi-structured interview approach was that I was unaware of the responses the interviewees could give mostly because there was an unknown factor to this, in terms of novelty or actual adoption, and I would to move the questions around as the interview progresses to get a better understanding of the respondents responses (Saunders & Lewis, 2012). The questions themselves had a combination of probing, specific and direct questions to get the best results as part of the development of the interview questionnaire (Bryman & Bell, 2015).

The interviews were setup in 30 minutes to 1 hour sessions dependent on availability of the individuals. It had a pre-set of questions relating to the topic to understand if there was a shift from knowledge to action from the exercise using gamification and human-robotic Interaction or if it was only a novelty and no such change existed.

The intent was to ask open-ended questions, such as reflective questions that do not lead to yes or no answers (Bryman & Bell, 2015), which would start off with the review of the sessions held a few months ago to lay the foundation of the discussion and purpose of the interview. The first three interviews were used as pilot interviews to see if the approach was correct and there are no leading questions that have been unintentionally developed to bias the study.

Interviews were run until saturation of data was reached. Saturation was reached after the eighth interview. The actual interviews were voice recorded with the consent of the interviewees and were transcribed post each session to ensure all comments and notes are captured correctly post the session.

4.3. Population and sample:

4.3.1. Population:

The target population was a set of diverse adult learners of varying ages who were all currently employed. All adult learners worked in western business model company which indicated their language of communication was English; however this would not be in all cases their first language. Also to note was that cultural influence would not be considered as a factor of this study. Senior managers from within the insurance sector would be selected for the interview based on consent given to be interviewed.

4.3.2. Sample and sampling method:

Non probability sampling method was used. The size of the first phase was 40 adult learners exposed to the workshop. The second phase the size varied based on availability to do interviews and consent given, the final number interviewed was 12 individuals. This involved convenience sampling method from a list of 40 members who attended the workshops (Saunders & Lewis, 2012).

4.4. Research instrument:

4.4.1. Phase One - Research Instrument Used:

The first phase used structured survey built using a Likert rating scale as well as a qualitative portion. The symmetrical five point likert rating scale (Joshi, Kale, Chandel, & Pal, 2015) was used and as phase two reflection of phase one would involve Qualitative portion to assist by creating triangulation to ensure validity and reliability for those candidates who consented for the interviews. Thus the findings in terms of the learners' response to the study should be the same as their rating (Bryman & Bell, 2015).

4.4.2. Phase Two- Research Instrument Used:

The qualitative process involved a telephonic interviews using the key questions in a semi structured format to get insights if the outcomes where successful or not. The conversation was recorded in each interview and transcribed and mapped to codes and themes (Saunders & Lewis, 2012). The voice recording device was tested before hand to ensure transcription of information was guaranteed and not only reliant on hand written notes, these were used as triangulation for the interview data gathering work to ensure validity and reliability (Bryman & Bell, 2015). This as further reviewed by a 3rd party who did transcription of voice recordings to ensure the gathered data was transcribed the same as what had been writen post each interview.

4.5. Procedure for data collection:

4.5.1. Phase One - Data Collection:

This was done as part of the co-delivered classroom modules. With consent from the program manager it was noted as part of this classroom session that the data would be used for research purposes and they were provided with a survey at the end to be able to understand if the actual classroom session met their needs and expectations based on the exposure to the skills that were being tested (World Economic Forum, 2018). This was done using "survey monkey" setup with a five point likert scale based on interval data and information was received back from all adult learners.

4.5.2. Phase Two - Data Collection:

The first interviews were used as pilot interviews to see if the approach was correct and there were no leading questions that had been unintentionally developed to bias the study. Interviews ran until saturation of data was reached.

The actual interviews were voice recorded with the consent of the interviewees and were transcribed post each session to ensure all thoughts and notes are captured correctly post the session. There were three interviewees that had time constraints and interviews had to be done via open ended questionnaires through email. Consent was provided in all cases.

4.6. Data analysis and interpretation:

4.6.1. Quantitative Analysis:

Looking at the recommendations made by Boone & Boone, (2012) to analyse likert data, consideration was given to the likert-type or likert scale approach. Since likert-type data was more focused on ordinal data our consideration for analysis was focused on likert scale data which was interval in nature. Basic quantitative analysis was used to test mean and average for the candidates in the classroom session to understand if they felt exposure to the five skills. The qualitative analysis was the more important output of this study.

4.6.2. Qualitative Analysis:

The technique recommended for Qualitative analysis, namely thematic analysis (Braun & Clarke, 2006) was used to do the analysis. This technique was used to identify patterns appearing within the gathered data which could be seen as open ended and difficult to interpret.

The intent was to define themes emerging from the gathered data which were built up by codes generated from the data itself. This was mapped back to the research questions to ensure the themes were aligned and not irrelevant topics are brought in, as Braun & Clarke (2006) noted "the 'keyness' of a theme is not necessarily dependent on quantifiable measures but rather on whether it captures something important in relation to the overall research question".

This was done through a ranking of each theme which was labelled and the counted each time it occurs and ranked accordingly from highest to lowest. It followed the inductive thematic analysis approach due to focus being strongly driven by the data that had been gathered in the interviews. Final report was done on analysis of the thematic themes outcomes and defining conclusions based on the themes and comparing it to the research question to understand if a clear outcome had been defined and what the results are (Braun & Clarke, 2006).

4.7. Limitations of research method:

4.7.1. Phase One - Quantitative Analysis Limitations:

The use of a five point likert scale did limit the candidates choices versus a seven point scale which could be a potential risk such as if someone ran the same test the candidate might choose a 3 the first time and then a 4 the second time but with their intent remaining the same (Joshi, Kale, Chandel, & Pal, 2015). Another risk was choosing the wrong of type likert to achieve the outcomes, whether one wants to measure individual items or measure the items as a whole. If the need was to measure individual items the likert-type would be chosen over the likert scale. However in our scenario we had chosen the likert scale to measure against meeting overall objects to see if indeed the workshop design was successful in transferring the five skills. Further to that there was the risk of the researcher seeing the quantitative data as a real world scenario that was applicable to other areas as well (Bryman & Bell, 2015), however with the use of the longitudinal study that has a qualitative component could can be tested.

4.7.2. Phase Two - Qualitative Analysis Limitations:

Qualitative research had the risk of being subjective and impacted by the researchers engagement with the parties being interviewed through relationship building due to the nature of the approach which generally had open-ended approach that requires narrowing down of the information being gathered which could be seen as a form of interviewer bias (Bryman & Bell, 2015). There was also the risk of interviewee bias due to the nature of the questions, such as requesting examples of where a case of change had happened (Saunders, Lewis, & Thornhill, 2009).

4.8. Validity & Reliability:

4.8.1. Reliability:

The ability to consistently produce the same findings is what the purpose is of measuring reliability (Bryman & Bell, 2015).

The quantitative portion of the study allowed for replication through classroom scenarios, these were done within the same sector and also within the same management level, in this study being senior managers. This helped reduce the risk of subject error (Saunders & Lewis, 2012). There was also the risk of subject bias which was caused by people expecting to provide a specific outcome due to being potentially been shown in negative light to their fellow colleagues (Saunders & Lewis,2012), this however was mitigated through the use of anonymity and the likert scale which limits outputs.

There were two approaches to qualitative research in terms of ensuring reliability, the one was internal reliability and the other was external reliability. The approach of using internal reliability was chosen where another researcher or participant reviewed what was noted to ensure the same outcome is interpreted and it does not differ from that which the researcher has defined (Bryman & Bell, 2015). This reduced the risk of observer bias and error.

4.8.2. Validity:

Ensuring that what was meant to be measured for the research is measured is the purpose of validity (Saunders & Lewis, 2012).

For the quantitative portion of the study, construct validity which ensured the measure was measuring the research outcome (Bryman & Bell, 2015), was managed through the longitudinal study by testing if the results remained the same and use of a likert scale helped focus the outputs towards what the studies intention was. The longitudinal part of the study also supported internal validity or causality to see if the intervention did in fact prove the intended outcome.

As with reliability, qualitative research has internal and external validity. For this study the use of internal validity was chosen as it allows for the testing of congruency over a period of time which is the purpose of the study that is being done (Bryman & Bell, 2015).

4.9. Conclusion:

The intent was to find and measure through intervention through classroom engagements and post interviews if this knowledge transfer methodology could provide an enhanced method of teaching adults new skills using the principles from gamification as well as human-robot interaction through andragogy, both understanding effectiveness of the skills delivery technique as well as the sustainability of those five skills post the engagement session. The next chapter looks at the results of the interviews, followed by the discussion around what the implications are and what it entails and then ending off with the final conclusion of the study.

Chapter 5: Research Results

5.1. Introduction to Results:

To test whether we could transfer knowledge sustainably using the theories that was reviewed as part of the literature review in chapter 2, we considered a two phase approach, for the first phase we used a class room setting with adult participants who have gave consent to partake in the exercise as part of a GIBS Programme to see if we could expose them to the top five skills that would be required post 2020, namely, complex problem solving and critical thinking, skills such as creativity and from a people perspective specifically people management and collaboration (Gray, 2016).

It followed a designed set of gamified scenarios built off the principles of gamification as a motivator to transfer knowledge (Wilson, Calongne, & Henderson, 2015) by incorporating the skills Gray (2016) had noted, through the use of human-robot interaction that allowed adults to teach the robots used in the study to accelerate their learning which Tanaka & Matsuzoe (2012). All of these were built on the usage of andragogy principles, namely, problem centred, learn to fail, involving learners to define how they achieve the outcomes required and supported by that the self directed teaching approach (Knowles, 1996).

Phase one ended with a likert scale survey asking the candidates if they agreed that they felt they were exposed to the five skills. This helped understand if it was possible to build an intervention that would enable knowledge transfer using gamification and HRI through andragogy principles.

The second phase followed a few months later with qualitative interviews to help understand if it was possible to sustain the skills that were transferred during the workshop as part of phase one. As part of the phase two interviews reflection questions were asked to understand if the twelve candidates still felt they were exposed to the five skills and also understand if the core principles of gamification, HRI and andragogy were prevalent, this would help support the findings from the survey during the phase one classroom sessions.

The outcomes of this study will be highlighted as part of this chapter in the results to follow.

5.2. Phase One Results - Quantitative Survey:

The classroom session took about an hour and a half, there were two of sessions which covered forty candidates in total. As noted in chapter 4 they were senior managers from the insurance sector attending the GIBS programme. The specific session was designed to look at applying five specific skills with the intent of insuring transfer of them. Post the session a survey was held asking candidates if they had felt they were exposed to the five skills during the course of the session, this was done using a five point likert scale, ranging from strongly agreeing(1) to strongly disagree (2) with Neutral being at 3. The findings are noted below per skill.

5.2.1. First Skill: Complex Problem Solving
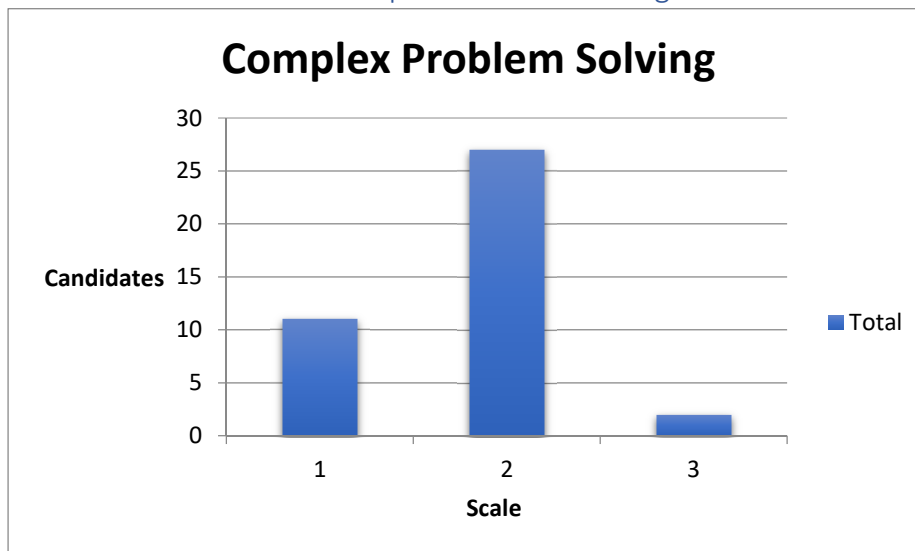
Figure 2: Complex Problem Solving Results

Median	2
Average	2

Thirty Eight candidates completed this question in the survey. Two candidates had taken a neutral view on being exposed to complex problem solving as part of the classroom session. Twenty four candidates felt that they agreed that the session had exposed them to complex problem solving while another twelve strongly agreed that was the case. This led to an average and median of "Agreed" had come across in the findings.

5.2.2. Second Skill: Critical Thinking
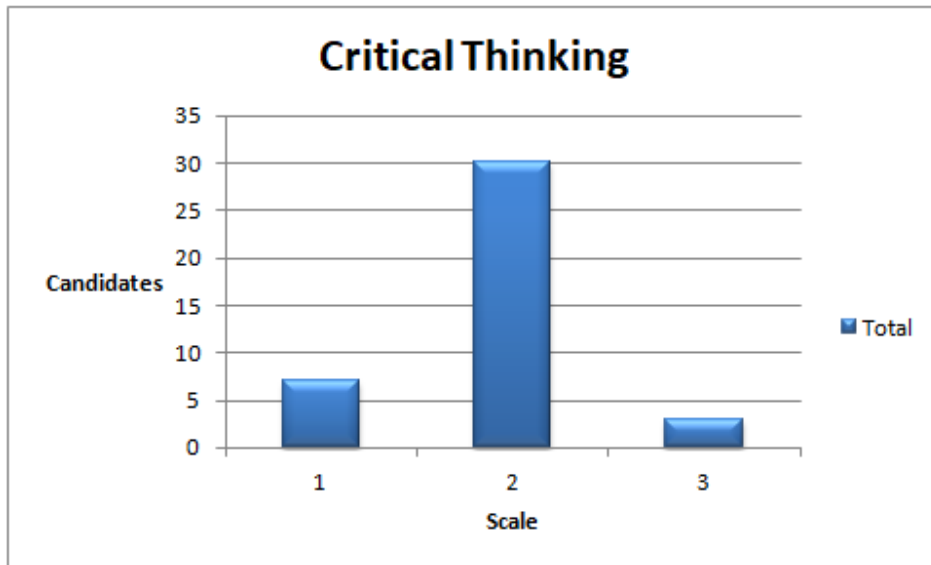
Figure 3: Critical Thinking Results

Median	2
Average	2

In terms of critical thinking and understanding if candidates had felt they were exposed to it, all forty candidates completed this survey question. Three candidates noted a neutral stance to this question. Thirty candidates agreed that they felt they were exposed to critical thinking as part of the classroom session and another seven strongly agreed they were exposed to this skill. Median and Average was both at "Agreed".

5.2.3. Third Skill: Creativity
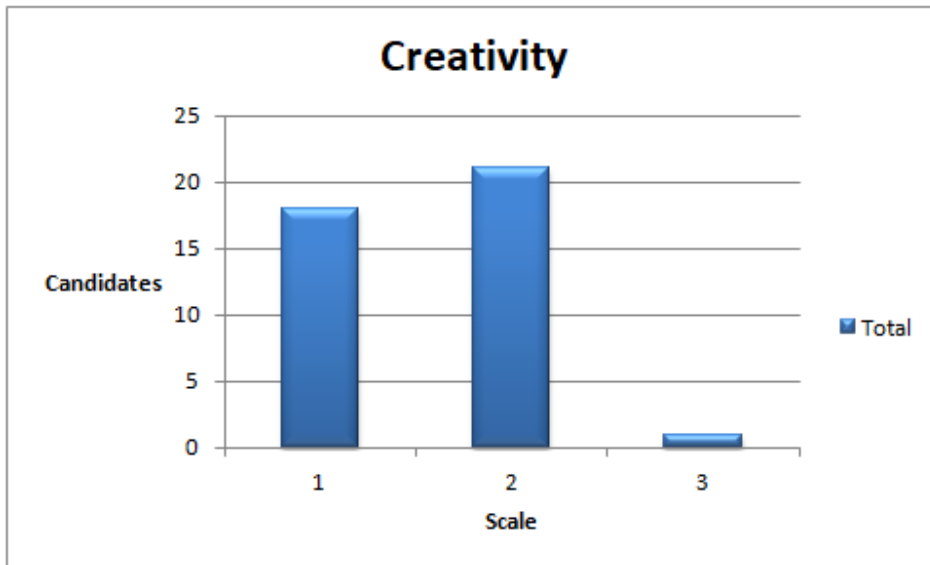
Figure 4: Creativity Results

| Median | 2 |
| Average | 2 |

All forty candidates completed the survey question relating to exposure to creativity. One candidate took a neutral stance to this question while twenty one candidates agreed they were exposed to creativity as part of the session. Another eighteen noted that they strongly agreed that they were exposed to creativity through the session. Median and Average were both "agreed".

Figure 5: People Management Results

Median	2
Average	2

All candidates also completed the survey question pertaining to exposure to people management during the session. This saw a higher number noting a neutral stance to people management exposure but twenty candidates noted they had agreed that they were exposed to people management as part of the exercise. A further twelve candidates strongly agreed they were exposed to people management. Median and average was at "agreed".

5.2.5. Fifth Skill: Collaboration
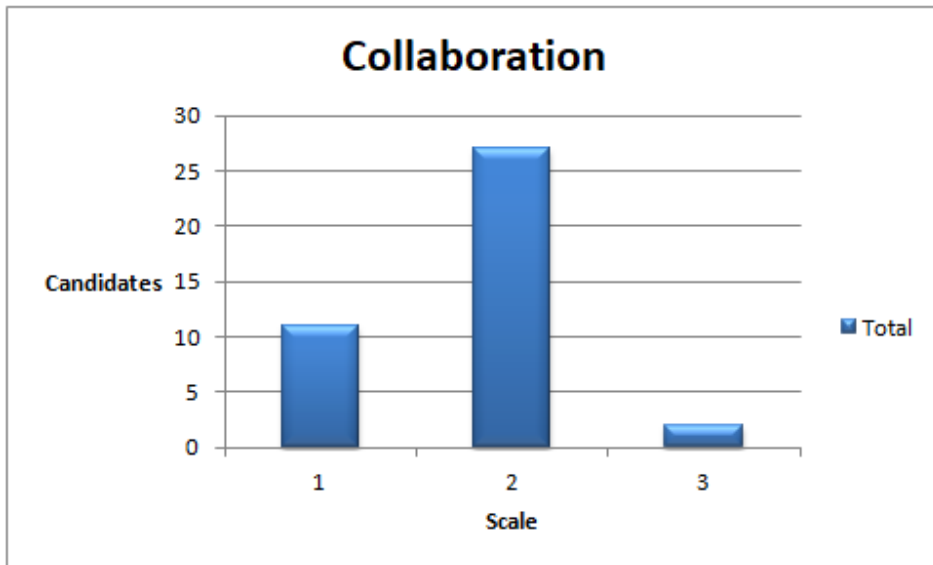
Collaboration

Figure 6: Collaboration Results

Median	2
Average	2

All candidates completed the question relating to exposure to collaboration as part of the session. Only two candidates took a neutral stance. Twenty seven candidates noted they agreed with being exposed to collaboration while another eleven strongly agreed with being exposed to collaboration as part of the session. Median and average were at "agreed".

Discussion of these results will be explored as part of chapter 6.

5.3. Phase Two Results - Qualitative Interview:

5.3.1. Description of Candidates and Roles:

Table 3: Interviewed Candidates

No	Gender	Role
Candidate 1	Male	Team Manager
Candidate 2	Female	Account Manager
Candidate 3	Female	Business Development Officer
Candidate 4	Female	Client Care Manager
Candidate 5	Female	Team Leader
Candidate 6	Male	Team Leader

Candidate 7	Female	Broker Consultant
Candidate 8	Female	Product Owner
Candidate 9	Male	Analytics Manager
Candidate 10	Male	Team Leader
Candidate 11	Female	Manager
Candidate 12	Male	Service Manager

As noted in chapter 4, the candidates all came from the insurance sector and where chosen as part of convenience sample from a list of candidates that attended the programme at GIBS.

Of the forty candidates contacted that had gone through the programme at GIBS only Twelve where able to make the time available for interviews. These candidates are listed anonymously above only with reference to gender and age to indicate the mix was balanced, though this was not planned as such and provides no relevance to this study. The roles where senior in nature as required by the development programme and all participants answered all the questions required. Of the twelve candidates, nine candidates participated in telephonic interviews which allowed note taking as well as voice records which were transcribed by a third party for accuracy. Three candidates had requested due to capacity and time constraints to provide feedback on the questions via email. In all twelve cases consent was provided by the candidates to use their responses for the purposes of this study.

5.3.2. Reflection on Phase One

The purpose of the first questions of the qualitative interview was to understand through reflection the twelve candidates still thought they were exposed to the five skills and if the elements found in HRI, Gamification and Andragogy were transparent to them this would help support the findings as part of Phase one survey.

5.3.2.1. Andragogy Framework Exposure

The first principle to consider around andragogy was if the GIBS session did create a sense of relevance to the learner's current environment. This was done by looking at the actual simplicity of the technology used during the workshop and how it was perceived easy to do programming of a robot to complete specific tasks and how this could be seen as relevant on how easy technology has become.

This came back with various responses but ten candidates felt it was definitely an indication of how the world was changing.

Candidate 2: *"Yes, definitely. It's very relevant."*

Candidate 7:*"Absolutely, without a doubt. I think robotics and technology is exactly the direction that the world is moving and to have been exposed to something like that whereas I hadn't before, was a definitely an eye opener."*

Candidate 8: *"Yes definitely. So after this session and going back into corporate and you know carrying on this normal work. Artificial intelligence is becoming more of an option in terms of how businesses planning going forward is what I think."*

Candidate 9*: "Yes I think so. Particularly with regards to the fact that this is not, no longer the domain of experts, but it's becoming the way of work, so that some kind of background people who wouldn't have been exposed to it before now much further exposed to it then they would have been before. And particularly when it comes to robotics around process automation and even the desk jobs, I think it's very relevant."*

Candidate 12: *"Yes opens your eyes up to what the future can potentially hold."*

There were also two candidates who supported the relevance to how the world was changing but not necessarily directly in their work environment.

Candidate 1:*"...But in my opinion, unless you have the connotation of exactly is happening in the room I think people might take the concept as just a fun day, if that comes across correctly."*

Candidate 10:*"I did see the relevance in the changing world but could not link it back to my daily operations."*

With one candidate indicating there was no relevance to the world changing.

This leads to the second principles that forms part of andragogy, if the adult learners would not be stopped by failure by persist until they found a solution, thus being questioned if they kept trying post them failing a certain scenario in the workshop.

Only one candidate noted that they would not keep trying, seven candidates all indicated they persisted regardless of failure from an individual perspective.

Candidate 1: *"Yes definitely. Like I said for me the coding aspect of it was obviously the most fun and when I was doing the coding and something wonked out, or I didn't place something in*

the right box, or I didn't use the correct connecting coding. Obviously I would delete the whole thing and start again, and I was motivated to keep on doing that because it was interesting for me to see the final results of what I did."

Candidate 3: *"Yes and no. Yes but it was that case of yes I want to but I also want to give my group a chance to learn as well, because it was kind of in the group environment it was like you had the people that were eager and the people that were less eager."*

Candidate 7: *"I felt frustrated and I felt as I said before challenged. So definitely yes I wanted to keep trying."*

Candidate 12: *"Yes but this is in my personality generally."*

Further to this it was found that one candidate had a fear of technology and used it to drive their will to succeed.

Candidate 11: *"No it's just for me I'm very scared of technology so I did want to perfect it but I was also very nervous to perfect it."*

Five candidates noted from a team perspective as well, rather than an individual one, that they persisted to try and succeed post initial failure of a task.

Candidate 2: *"When something didn't work and we find out how till I had to read the instructions or take over so the collaboration was quite sick."*

Candidate 5: *"Yes, especially with different… you gave instruction sheet where we had to follow it to get specific movements. So if we not getting that movement we are so adamant, we wanted to find out what is it that was wrong about it."*

Candidate 10: *"Yes, we as a team kept trying until we could get the robot to move as we wanted."*

One candidate even further noted that it was not about the failure but rather the lesson being learnt as part of the exercise.

Candidate 6: *"Absolutely. I think that speaking to the team in any bit of challenge was a learning opportunity. I mean that is what the whole thing was about. It wasn't about whether you passed or failed. It was about if you learned something and take away from it. So I didn't feel like I was discouraged from trying to get it right. Failure was just learning a way not to do it."*

The next principle that forms part of andragogy is that it is problem centred, moving away from just looking at theory but moving it into practice. To test if this was applicable we looked for responses that indicated the activities where problem driven.

This we found five candidates making direct reference to it during their interviews.

Candidate 2: " It was a lot better being practical than theory, and the robots were really fun to play with."

Candidate 3: " Yes. So instances very complex. We don't work with that stuff every day, just saying."

Candidate 5: "So if we not getting that movement we are so adamant, we wanted to find out what is it that was wrong about it."

Candidate 8: " ..... Getting to the next step for me was a big thing because I had never been this exposed to it."

The last principle looked to understand if the candidates felt they had applied what they learnt from the workshop as a whole in the open test at the end that involved a competitive race that only had a goal they had to achieve without rules or guidelines.

Ten of the cases felt they had been able to apply what they learnt, being able to apply it when the test started.

Candidate 1: *"Yes definitely. I mean obviously the fact that it was a bit of a puzzle made it more interesting."*

Candidate 11: *"Without a doubt yes. Having not gone through all of those steps we wouldn't have got to that end result I don't think. I think that there are processes that you need to go through in order to get to a certain point in which case we did."*

Six cases stated that it generate competitive behaviour to achieve a goal of which one walked away due to the competitive nature that had within themselves.

Candidate 2: *"We did, we were very competitive so we always trying to win. So any competitive type would have gotten us to work harder or smarter whatever the case was."*
Candidate 9: *"I'm just irritated that I didn't win. (laughing)."*
Candidate 12:*"... everyone became extremely competitive at that point."*

Candidate 11:" *I actually stepped away from competition because I get really competitive. So for myself I actually stepped away and let the others run the competition.*"

There was one case that felt that they had not applied what they had learnt during the process. The study also came across another case where the candidate indicated that it had opened their minds to what was possible.

Candidate 8: " *More than I thought. I think beyond the class it changed my thinking like I previously said. It opening my mind to possibilities that I never thought were near.*"

5.3.2.2. Gamification Framework Exposure

The first principle of gamification is that it creates a sense of "fun" as a process of delivering a learning through this technique if designed correctly, this was observed by eight candidates during the interviews.

Candidate 6: *"...the first part is if I enjoyed it? Yes I thoroughly did..."*

Candidate 10: *"Was fun to see and partake in ...."*

Candidate 12: *"...group work definitely exposed up to collaborating with others in a fun way."*

The second principle that is considered a big component of gamification is that it acts as a motivator to drive candidates to carry on with the session they are being exposed to without an instructor pushing them to do so.

This was noted by nine candidates that they definitely felt they were motivated by the technique.

Candidate 1: *"I was quite motivated and I really enjoyed it. I tried to see how much I could get done with the robots, maybe not things that were planned in the actual plan. I mean I was halfway through the lesson trying to do my own things, but I mean that was something that I enjoy."*

Candidate 7: *"I thought the concept was very exciting, it was innovative and yes I was just really looking forward to it."*

Candidate 12: *"The robotics aspect added a level of excitement to the session. This also assisted us in seeing practically what robotics is capable of. I think it was a great ice breaker."*

One candidate found motivation through others progressing through the scenarios given.

Candidate 9: *"I think what was quite cool is seeing everybody else learning it. You know it was quite cool to see. I enjoyed the learning on the other people's behalf I guess . As well as that I just think that it's incredibly cool."*

Others felt motivated through collaboration with others also helped with the motivation.

Candidate 6: *"So I think when I have a collaborative environment it definitely promotes better work and I like that and enjoy it. That motivated me."*

Though one candidate noted no motivation while another noted that motivation was driven by the facilitator of the session rather than the session itself which would speak more to pedagogy.

Candidate 8: *"I guess the facilitator."*

This is further supported by participation in a learning event, which is generally considered as a part of motivation but the candidate above that felt the facilitator was the motivating factor also noted it took time to get into the session.

Candidate 8: *"It is a bit daunting in the beginning, but nearing the end it got a bit better and I was eager."*

As well as that motivation in a group perspective was seen as the team started working together for a longer period of time.

Candidate 8: *"...in the group there were people of different experiences and we all received the latter differently. Some were more eager than others to try something else, and others were a bit scared of what is out there and couldn't relate so much. But I found that as the class continues, we became more on the same page you know."*

With this feedback from the interviews it indicated that there was elements of gamification that where being perceived by the candidates as being portrait through the session they attended which will further be explored as part of the discussion session in chapter 6 of this research.

5.3.2.3. Human-Robot Interface Exposure

HRI is able to act as a motivator as much as what gamification does, we wanted to understand from the candidates is this was true and they felt there was any sense of motivation coming through during the session that would be directly attributed to the robots themselves. This was observed by some of the candidates.

Candidate 1: *"Having the experience of seeing the robots and seeing how simplified coding can actually be made, through a application to get something done. Simple as the Drag and drops step by step sort of process. I was quite motivated and I really enjoyed it*."

It also can change a candidates perceptions around technology itself such as noted by this candidate.

Candidate 5: "....related to the Internet of things like where things are going as certain roles, as time goes by things will become redundant because of the implementation of such things. Such as robotics to do the work more efficiently than human beings."

Also showing candidates how easy technology has become.

Candidate 1: *"Having the experience of seeing the robots and seeing how simplified coding can actually be made"*

Candidate 5: *"I did a little bit coding in school. I didn't enjoy it but I think the simplification of the coding that you actually did for us, it was actually amazing."*

Considering that HRI will be integrated into education at some point, one candidate noted that their niece already has exposure to it through her Biochemistry degree. Which is similar to the BUSA Dig case noted in chapter two (Blain, Ferworn, Li, Tran, & Carter, 2017).

Candidate 5: *" ...recently I had a conversation with my niece. She's doing a BSC biochem, I just forgot the actual name for it. What they are basically doing, it actually includes robotics to actually resolved certain problems that the field is actually facing. So when she was talking about it I found it quite easy to interact with her because it's something that I was exposed to and it's something that I understand how it is going to Impact the future."*

Further supported by HRI application in a practical scenario to solve a problem, similar to the above scenario, the last part of the GIBS session had a test the students need to apply practical leanings to. This required them to apply everything they learnt plus think out of the box and solve a problem within a time limit through competing as teams. Thus to understand as part of the study, as in andragogy, were they able to apply what they learnt practically in a short period of time, similar to the BUSA Dig exam case (Blain, Ferworn, Li, Tran, & Carter, 2017).

Candidate 1: *" Yes definitely. I mean obviously the fact that it was a bit of a puzzle made it more interesting. The fact that it had to move forward, stop and turn and stuff like that, me being as competitive as I was (laughing) I was trying to be first."*

Candidate 2:*"We did, we were very competitive so we always trying to win. So any competitive type would have gotten us to work harder or smarter whatever the case was."*

Candidate 10: *"I think it was almost like a test to establish what we have learned through the day."*

Candidate 12:*"Yes definitely, everyone became extremely competitive at that point."*

With HRI we saw practical application of what was taught directly to the candidates over a short period of time during the workshop which was tested at the end with a competitive challenge. This will further be explored as part of chapter 6.

5.3.2.4.   Exposure to the five skills

As noted before the five skills that were chosen was creativity, collaboration, people management, critical thinking and complex problem solving.

The candidates were questioned as part of the interview if they felt any exposure to these five skills and if there was any examples thereof as proof they could note looking back at the session.

The first skill that the candidates were queried on was collaboration, it found that eleven of the candidates had considered that they felt they were exposed to collaboration as a skill.

Candidate 2: *"Oh we did that a lot. When something didn't work and we find out how till I had to read the instructions or take over so the collaboration was quite sick."*

Candidate 5: *"Of course yes, because there were instances in my team there instances where we got stuck in one point like everything else is working fine except that small part and then there was one guy who actually understood what was supposed to happen. Though we had to actually partner with him and ask him to give us instructions so we could actually resolve what the problem was"*

Candidate 6: *"As part of my team yes definitely."*

Candidate 8:*" I think it becomes easier to get into it than you have people that support and motivate, and show that its possible. So that when you collaborate, when you are working together, when you get stuck you've got somebody who can help. So I think yes."*

Candidate 9:*"Yes definitely. I think it was quite cool to see how they picked up and learned about it. But also working, collaborating and solving problems . Look I think anybody or groups*

who hadn't had some prior knowledge around this kind of stuff I'm sure that that collaboration must have been through the roof."

Candidate 10:*"Yes, when making turns to programme the robot and we saw that it wasn't doing what it should we collaborated with one another to rectify the steps which we programmed incorrectly."*

Candidate 12:*"Yes the group work definitely exposed up to collaborating with others in a fun way."*

The second skill that was queried was complex problem solving to understand if this has been carried across during the session. Nine candidates clearly indicated they felt this was being carried across.

Candidate 1: "*Well yes, there's definitely a certain aspect of complexity in the way that it gets done. Like I said the problem solving aspect to me was more in relation to the hook coding...*"

Candidate 3:*" Yes. So instances very complex. We don't work with that stuff every day, just saying."*

Candidate 6: *"I think it equipped me to deal with more complex issues, or challenges that I may face in the future. And I would know that I need to dig a little deeper and to understand the mechanics of something before coming to any solid conclusions. So there's no specific example but I think that if I had been in that environment I would have learned something that I'm going to apply."*

Candidate 7: *"Yes, I was certainly exposed to that. Whether I was any good at it that's a different question all together."*

Candidate 8: *" Yes just getting the coding was rough. It was problem solving skills. Getting to the next step for me was a big thing because I had never been this exposed to it."*

Candidate 11: *"When we were working as a team to try get everything, when you had to get that thing working on the phone that for me was abstract. That was difficult for me."*

Whereas two candidates felt strongly that was not the case.

Candidate 12: *"No not particularly."*

The next skill looked at was creativity to understand if this had been successfully applied. It was found that eight candidates felt that they had been exposed to creativity.

Candidate 1: *"...from a creative perspective I think that it was one of the key takings from that exercise. The fact that a person can, especially afterwards when the whole script was followed and we had done everything we needed to in the manual. Where there was a little bit of time, where it was said free roam for twenty minutes or thirty minutes or however long it was."*

Candidate 5: *"Yes it actually showed, it proved the point that there is more than one solution to solving the problem."*

Candidate 6: *"So it's something that I have never been exposed to and it pushed me into an area of knowledge that I had nothing that I had no knowledge about. So that by itself offered a creative aspect of learning."*

Candidate 8: *"I think yes, it's just difficult to give an example because I think this was more of a opening your mind. For me that session was more opening my mind to something that had previously blocked out, and what's possible you know. If you creative wants possible. Like in my solution, as to where I am now in my current job. I'm not limited to the tried and tested. I now know that the alternatives are options that you should consider. Outside of the norm."*

Candidate 9: *"Yes. I think it was good in a sense of you are linking certain things together, starting off with something you couldn't do something then you ended up with this machine that could do something more then it could do before. So I guess its kind of a creativity."*

Candidate 11: *"Well you had to, it wasn't just a black and white kind of exercise. You had to be creative about it and think out the box."*

Candidate 12: *"Yes you had to be creative whilst controlling the robots."*

There were also four candidates that did not believe that there was any creativity in the session being applied.

Candidate 2: *"I wouldn't say creativity. I think there could be an element in it if it's a what do you think the robot can do, which could be a different element to it. But not too much creativity."*

Candidate 7: *"Forms of creativity, I don't know about that. The programming seemed quite specific. So I don't know whether I felt very creative? I felt like I needed to follow instruction."*

People management followed the above question to understand if the candidates had felt that had been exposed to this, which was considered a different skill to collaboration as it required the candidate to be able to get other team members to do something they potentially couldn't do or needed to help work together to support a collaborative approach to the problems.

Eight candidates felt they had been exposed to people management, either through them needed to help someone else or getting someone else to do something specific.

Candidate 1: *"Yes look in the team that I was working with, there was one or two people that were not as exposed to electronics or didn't really understand the idea of coding. There was one lady in particular where I found myself sort of latching onto her and you saying you know, because she was getting slightly frustrated with the idea and not understanding exactly how it works. Where I sort of latched onto her and said no, let me show you how this works."*

Candidate 5: *"Yes we do because as we were doing it as a team when you encounter a problem you get to a point where somebody gets to the point of how do I solve this problem? But other people find that they are still lost. So you really had to translate information in the simplest of terms so you can actually understand what is it that you trying to fix in that entire problem that you were doing."*

Candidate 6: *"So each person in our team, as we were going through the content and figuring exactly what we needed to do, we realised that one person understood it a little bit better, so we did rely on them."*

Candidate 8: *"Yes because in the group there were people of different experiences and we all received the latter differently. Some were more eager than others to try something else, and others were a bit scared of what is out there and couldn't relate so much. But I found that as the class continues, we became more on the same page you know."*

Candidate 11: *"Yes, because when you were working as a team, everyone wants to kind of jump in at once. So you have to control that and kind of work with everyone's strengths."*

Another candidate noted that no people management was required as their group naturally worked without any intervention.

Candidate 2: *"Not really with us. It we were fairly gelled group, and we were really good with sharing the robot so it wasn't much people management required."*

A further three others noted that there was also no people management in their groups.

Candidate 10: *"No, we made turns programming the robot so there was no need to manage the team."*

The last skill that was looked at was critical thinking, as part of this it was found that ten candidates believe it was applied during the session.

Candidate 2: *"I think there was but I've got a development background so I'm used to code whichever form it is. So it was quite familiar to me regarding critical thinking was definitely there."*

Candidate 5: *"Yes. I found myself trying to, while following the instructions that you gave us on the paper, when you do something wrong you want to find out what it is that you missing."*

Candidate 8: *"Yes. I'm just trying to remember. All I know is that exercise made artificial intelligence a more viable option or real option. It became easier for me in my corporate life after that to entertain it, as I went through that exercise."*

Candidate 9: *"Yes for me a month, and after what's happened after that current time period. So to critical thinking. I think a lot of it has got to do with how you sequences things and problem solving. So about building up a set of steps if it doesn't do what you expect then kind of think what could have gone wrong. Particularly when you have kind of conditional loops, IF statements, those kind of things. So I remember roughly kind of how we were building them, but I would say that's very generic that I think that's kind of solving any problem."*

There was one candidate that thought it was not relevant to their industry which might also be that the interpretation of critical thinking was incorrect but it is noted as a negative result, there was also another candidate which noted that they did not believe there was any critical thinking as part of the process.

Candidate 6: *"So the critical thinking portion of this is somewhat limited and the reason I say that is because the industry that we are involved in. Whilst it deals with manufactures and how they produce, well more specifically for me it's in insurance. So how they dealt with the whole operational structure and how business automation is done through robots, in my current work I'm working on the phone and I'm administering claims. So I can't really say that there's an opportunity for me to go and practice what I have learned."*

Lastly there was another candidate which believed there was but only to a small extent.

Candidate 12: *"Yes to a small extent, this was done in a group under a time limit so you didn't enough time to go through in detail."*

These results relating to the skills transfer during the GIBS session will be reviewed further as part of the results as part of the review in chapter 6.

5.3.3. Results Phase Two - Skill Retention

The purpose of the second question was to understand if knowledge transfer did occur was it sustainable and what, if anything, did change in the candidate nine months after they were exposed to the workshop.

5.3.3.1. Identified Themes

It was noted from nine candidates of the twelve that they felt they had adopted one of the five skills due to exposure of the workshop. Through further analysis seven themes emerged.

Table 4: Identified Themes

Theme	Candidates
Collaboration to find Solutions	8 Out of 9
Fun to Learn	8 Out of 9
Relevance of Changing World(VUCA)	8 Out of 9
Continuous Learning	8 Out of 9
Direct Application at Work	7 Out of 9
Competitive Element	6 Out of 9
Taken out of Comfort Zone	5 Out of 9

5.3.3.2. Theme 1: Collaboration to find Solutions

Eight of the candidates of the nine that had retained one of the five skills noted that they had approached the original session working with their team to find solutions to the problems in the scenarios versus trying it individually.

Candidate 1: *"There was one lady in particular where I found myself sort of latching onto her and you saying you know, because she was getting slightly frustrated with the idea and not understanding exactly how it works. Where I sort of latched onto her and said no, let me show you how this works."*

Candidate 3: *"So making sure that although I have the answer you know, give someone else a opportunity to have the answer as well. And then kind of motivating other people to find the answer, so from that aspect."*

Candidate 7: *"I think a lot of learning subconsciously took place in that specific class. With regards to collaboration, with regards to delegation and just how you interact with one another, in terms of a frustrating situation which I know our team certainly felt and I do think that that has had a direct impact."*

Candidate 8: *"I think it becomes easier to get into it than you have people that support and motivate, and show that it's possible. So that when you collaborate, when you are working together, when you get stuck you've got somebody who can help."*

5.3.3.3. Theme 2: Fun to Learn

Another theme that emerged was that eight of the nine candidates found a lot of fun and excitement in the exercise.

Candidate 3: *"...because it's a different way of learning, and it's a fun way of learning."*

Candidate 5: *"I think the simplification of the coding that you actually did for us, it was actually amazing."*

Candidate 7: *"I thought the concept was very exciting, it was innovative and yes I was just really looking forward to it."*

Candidate 13: *"Yes, Robotics is a hot topic worldwide and learning more about it even as a side note to a larger issue makes learning fun."*

5.3.3.4. Theme 3: Relevance in a Changing World(VUCA)

A third theme that came to light amongst eight of the nine candidates was the understanding relevance of how the world is changing around the candidates which they had not been exposed to before.

Candidate 7: *"I think robotics and technology is exactly the direction that the world is moving and to have been exposed to something like that whereas I hadn't before, was a definitely an eye opener."*

Candidate 8: *"So after this session and going back into corporate and you know carrying on this normal work. Artificial intelligence is becoming more of an option in terms of how businesses planning going forward is what I think."*

Candidate 13: *"... opens your eyes up to what the future can potentially hold."*

5.3.3.5.   Theme 4: Continuous Learning

The fourth theme that was prevalent amongst most of the candidates, eight out of nine, was continuous learning, candidates had indicated that the session itself had given them a drive to take on new learnings.

Candidate 1: *"Yes so from that exercise, the number one where I can maybe tie back into a real world situation but I'm actually currently try getting into JAVA script coding. I know its not 100% the same thing but it is an additional skill that I realised throughout the program again that it's something I might need to learn to actually have some application skills where I can possible assist them in writing applications for the real world, where we can do like workforce management coding or skill coding or whatever the case will be."*

Candidate 5: *"I actually after that I participated in our company participated in a whole lot of workshops that they were doing. It's not exactly a workshop but it's like a training program where it was more about leadership for women and we found that you had to do excursions to get involved in trying to resolve the problem that society is facing."*

Candidate 7: *"I have decided that I do not want to learn computer programming (laughing). What did interest me is that I find that I am reading a lot more in terms of fintech development as to what is happening and the way the world is evolving with regards to robotics. I know in terms of my own business."*

Candidate 11: *"I do want to learn something new as often as I can. I am now taking part in events hosted by the IIG where there is Insights into things affecting the Insurance Industry."*

5.3.3.6.   Theme 5: Direct Application to Work

Another major theme emerged from seven of the nine candidates, this was their application of actions at their places of work post them attending the session which they had not planned to do prior to attending the session.

Candidate 1: *"I realised throughout the program again that it's something I might need to learn to actually have some application skills where I can possible assist them in writing applications for the real world, where we can do like workforce management coding or skill coding or whatever the case will be."*

Candidate 7: *"I know in terms of my own business, we are just placing robotics into the call center and into, we just launched a fund this coming Monday with regards to, there's no human intervention at all and I think my interest has been sparked as a result of that specific class."*

Candidate 8: *"I presented…..solutions for a job function that we have. That felt like we could get a system or a robot that can replicate and do the work"*

Candidate 11: *"The critical thinking is the biggest skill that I took from said course and am currently working on. We launched systems and a lot of thinking had to go in to how operations would like these systems to work, look and feel to benefit and simply staff's daily tasks."*

5.3.3.7.   Theme 6: Competitive Element

Six of the nine candidates raised another theme relating to competitive behaviour being prevalent in their engagements.

Candidate 1: *"The fact that it had to move forward, stop and turn and stuff like that, me being as competitive as I was (laughing) I was trying to be first."*

Candidate 2:*"...we were very competitive so we always trying to win. So any competitive type would have gotten us to work harder or smarter whatever the case was."*

Candidate 12: *"I actually stepped away from competition because I get really competitive."*

5.3.3.8.   Theme 7: Taken out of Comfort Zone

Finally to a lesser extent five out of the nine candidates had noted they were taken out of their comfort zone during the original session.

Candidate 7: *"I wanted to make the robot move. I felt challenged. I took it upon myself as a challenge to make the thing move."*

Candidate 8: *"It is a bit daunting in the beginning, but nearing the end it got a bit better and I was eager."*

Candidate 12: *"...just for me I'm very scared of technology so I did want to perfect it but I was also very nervous to perfect it."*

5.4. Conclusion to Results

As part of Phase one the study looked to establish if the techniques applied on the day of the workshop was seen by the candidates as valuable in terms of knowledge transfer using

gamification and HRI underpinned with andragogy principles to see if they experienced exposure to the five skills. Covering the results of these core areas, most candidates had felt that they experienced the underlying content transfer as well as exposure to the principles of gamification and andragogy. Even further they felt that HRI acted as a form of motivator and application thereof created a more practical component to the session itself.

As part of Phase two seven major themes emerged amongst the nine candidates who confirmed they had applied some of the five skills differently or for the first time from their perspective attributed to the GIBS session itself.

These themes tied closely to elements from Gamification, HRI and Andragogy, the next chapter will consider these results and provide a discussion around them to finally lead into the conclusion of this study.

Chapter 6: Discussion of Results

6.1. Introduction to Discussion of Results:

This chapter looks to explore the results that have been collected through the interviews and defined in chapter five. The results are related to the research questions from chapter three and intended to understand if the use of HRI and gamification can bring about knowledge transfer and reduce the knowledge to action gap if applied with the principles of andragogy. This chapter will look and exploring the results further by taking the positive and negative content and apply the literature from chapter two to support and build on the findings.

6.2. Discussion of Research Question 1:

Can one design a module using andragogy principles, gamification and HRI to teach the skills required for the future?

6.2.1. Future Skills Translated Through Technique

As noted on the day of the GIBS session the intent was to subtly transfer specific future skills through the gamified scenarios using HRI. The forty surveyed and twelve interviewed candidates were queried if they had found any exposure to this skills as part of the workshop itself. This would support Zenk, Crowell, Villano, & Diehl (2017) seeing non-technical skills being transfered using a non-conventional method. This was further supported by Davies, Fidler, & Gorbis (2011) noted that experiential learning would become important to transfer new sets of skills versus traditional methods.

The five skills, as noted before, was creativity, collaboration, people management, critical thinking and complex problem solving (Gray, 2016).

The first skill was collaboration, according to Lindeke & Sieckert (2005) this is considered as two way communication with no element of supervision occuring during the discussion. As part of the survey twenty seven candidates noted they agreed with being exposed to collaboration while another eleven strongly agreed with being exposed to collaboration as part of the session, during the interview eleven out of twelve candidates noted they experienced collaboration during the session, a further note on this is that the candidates themselves were in small teams of three to four members and this could have aided in making collaboration easier but it would have been necessary to collaborate to achieve the outcomes of the tasks as some members

would have needed to decipher the work that needed to be done while others had to physically do the programming to get the robot to execute the tasks provided.

The second skill that had to be considers was complex problem solving, it was potentially more applicable in the last component of the tasks, namely the test at the end, the reason for this is that complex problem solving is considered a process of trying to understand the unknown, which would have been the programming of the robot during the race, and apply it to an every changing environment, which would have been the exposure to the changing competitor tactics (Greiff, Wustenberg, Holt, Goldhammer, & Funke, 2013).

To support this as part of the class survey, twenty four candidates felt that they agreed that the session had exposed them to complex problem solving while another twelve strongly agreed that was the case, during the interviews nine of the twelve candidate felt strongly they were exposed to this skill during the task though two candidates in the interview did not they did not feel exposed to this skill at all as it was not as complex for them, one of them being a candidate that did have past programming experience.

The third skill was creativity, the intent of bringing this skill in is that it lead to innovation according to Calabretta & Kleinsmann (2017) and was considered critical to businesses to have leaders able to adapt to constant change (Baker & Baker, 2012). The findings for the class surveys indicated that twenty one candidates agreed they were exposed to creativity as part of the session. Another eighteen noted that they strongly agreed that they were exposed to creativity through the session, while eight candidates of the twelve that was interviewed noted they felt they were exposed to creativity and it was something they had to apply in the tasks they were given, there were even candidates that played around between tasks by experimenting with the robots and the programming.There were also four candidates from the interview who felt there was no creativity and that the sessions were more task orientated.

People management is considered as the utilisation of people through leadership to understand strengths and weakness and best actions to achieve a common goal (Gresse, 2017). As part of the class survey twenty candidates noted they had agreed that they were exposed to people management as part of the exercise. A further twelve candidates strongly agreed they were exposed to people management. During the interviews eight candidates said they had been exposed to people management, requiring either the stronger members to guide those that were not sure of what to do or alternatively best utilising capacity to drive out components of a task that needed to be done.

One candidate during the interview did however note that purely based on the strength of their team there was no need for people management as they were all fully aware of what needed to be done to achieve the objectives given to them. There were also another three candidates who felt they had no exposure to people management in their teams during the workshop exercise.

The final skill that was queried with the candidates was critical thinking, this related to individuals being able to outline strong arguments and analysis to evaluate and get to understand a specific piece of content (Davies M. , 2013). This would have occurred throughout the workshop session as each task or test, including the final one, had components that required reflection of what was done and what should be done to achieve an outcome with the team as well as with the equipment and knowledge that was provided during the session.

Those surveyed post the class session, thirty candidates agreed that they felt they were exposed to critical thinking as part of the classroom session and another seven strongly agreed they were exposed to this skill. Ten of the twelve candidates interviewed noted they believed they were exposed to critical thinking throughout the session, though one candidate interviewed noted only possibly to a small extent, and another candidate interviewed felt they did not get any exposure to it or it was not something they would apply in their industry.

6.2.2. Andragogy Framework Exposure

To understand if the candidates found the GIBS session relevant to how the world was changing, we had queried if they supported this view. This supports one of Michael Knowles' principles around the difference between pedagogy and andragogy which see the andragogy learners looking for relevance in what they are learning, which makes it easier for them to understand the importance of the content as well as be able to apply it to their current surrounds practically (Knowles, 1996).

It was found that majority of the candidates, ten out of twelve interviewed, had found it relevant to the way the world was currently changing and impacting their work environment whether currently or potentially so in the near future. O'Toole & Essex (2012) referred to this as "in the moment learning" which meant that the learners where being exposed to content that was relevant and impactful to their everyday lives.

Two learners interviewed however felt there was no relevance to their working environments but this was potentially seen as not understanding what could potentially happen with the impact of technology especially with the obsolescence of current skills (Davies, Fidler, & Gorbis, 2011)

and the potential of newly created skills that don't currently exist that would be created by technology spill over (Sun & Fan, 2017).

To understand if learn by doing and feedback on failure was being attributed to the lessons in the workshop, which was another principle underpinning andragogy (Carmeli, Gelbard, & Reiter-Palmon, 2013), the candidates where asked during the interview if they had persisted post failure during a certain point in the exercises provided in the workshop.

Seven candidates interviewed concluded that they kept trying post failure from an individual perspective, one candidate noted that their fear of technology kept pushing them to succeed and five candidates, some part of the seven candidates noted above, said they were driven as a team effort to succeed in achieving the goals even if it was not always successful. This is supported by one of the assumptions Taylor & Kroth (2009) makes about andragogy that it is more self-concept driven rather than instructor driven and it comes through in the findings from this study especially with the feedback from the candidates interviewed.

O'Toole & Essex (2012) noted in their research that there would be scenarios where a pedagogical model would need to be used to apply interim theory before andragogical models could take place. This was simulated at the beginning of the workshop by introducing the candidates to what would be done and what the fundamental building blocks of the programming would be so that they could use to those building blocks to solve problems and have an understanding of the basics of navigation through the development platform. This had the same findings as the results of the case noted by Taylor & Kroth (2009) with the law students, seeing them understand theory first then go and apply it in a real world scenario such as the scenarios provided to the candidates in the GIBS session.

Also further to this one of the candidates interviewed noted that they were happy to just take the lesson of learning rather than be concerned about the goal as it was more important to them. This also can be seen from another assumption in andragogy which states that learners in this model bring a wealth of experience with them rather than starting on a zero base such as in pedagogy (Taylor & Kroth, 2009). This candidate felt they were learning for application rather than the content itself which speaks to experience rather than following content blindly. There were two other interviewed candidates who had also a background of programming and found the lessons more important and relevant than the programming itself.

A third principle in andragogy is a problem centred approach to learning (Knowles, 1996). During the interviews it was queried to understand if there was any link to this from their

perspectives or if they had felt that it was just a cookie cutter approach. Five of the interviewed candidates noted in their interviews that this was the case and ten of the interviewed candidates had found that they had to apply what they learnt to complete the last task of the workshop which was a competitive race.

This is further supported by Taylor & Kroth (2009) that an assumption in andragogy is that learners have a desire to learn which can be seen by the majority of the candidates, ten specifically, interviewed and how they had applied what they learnt to compete in the end against each other. This also is seen as another assumption Michael Knowles makes in that learners have an orientation to learn and apply directly those learning's rather than postpone it (Knowles, 1996), though in this case it was a required goal the candidates had to achieve to finalise the outstanding objectives of the lesson.

Finally the competitive portion of the workshop, the competition at the end as noted above, saw six candidates noting in their interviews that they had found it very competitive which motivated them to do it and one candidate avoid it altogether due to their very competitive nature. This aligns with another assumption made about andragogy is that it generates a sense of motivation in the learning process (Sogunro, 2015).

These findings mitigate against the risk Sharan Merriam's raised that they noted that andragogy is only a framework or a model and is at risk of not being applicable (Merriam, 2001) as it is indicated above that majority of the candidates had felt they had applied to all the principles and assumptions underlying andragogy as a framework.

6.2.3. Gamification Framework Exposure

Gamification is considered the "fun theory" (Huang & Soman, 2013) used to apply a different sense of motivation into a blended learning exercise. It was applied as part of the GIBS session as a core component of the lesson setup.

It was observed by eight of the candidates interviewed that they took the session as a whole as fun in terms of delivery of content. This supports Freeman & Freeman (2013) research in terms of making it easier to delivery content if learners are more engaged in the process.

Nine candidates interviewed had felt they were motivated during the session itself, which is seen as a pre-requisite to drive knowledge transfer in adult learning (Sogunro, 2015) and generally drives positive outputs as part of the exercise (Roth, Schneckenberg, & Tsai, 2015).

Huang & Soman (2013) found that this leads to a stickiness factor in terms of knowledge transfer in content, which came across seeing ten of the candidates interviewed feeling they were able to apply what they learnt through the session. It also helped with adoption of the specific programming language that was required to be used as out of the twelve candidate only two had past exposure to programming in their careers or studies and this supports Azadegan & Riedel (2012) in terms of what they found in their research regarding gamification providing a strong platform of change management.

The process during the workshop, especially the programmable competitive race at the end allowed candidates to reach the goal in their own way. This Johnson, Garrison, Hernez-Broome, Fleenor, & Steed (2012) identified in their research that goal setting was important for gamification for it to be successful.

In their research, Nelson (2012) discovered that self-expression had helped in the gamification process versus traditional learning methods, this was a component that came out during the competitive portion at the end that the candidates partook in. One candidate interviewed had found it more important to do this through others by supporting them and another felt it was more important to drive collaboration as part of the team to achieve this.

As part of the competitive component we also saw another candidate pull out due to increased competitive behaviour which Hamari, Koivisto, & Sarsa (2014) saw as a potential pitfall in the utilisation of gamification.

One candidate interviewed did find they were more motivated by the facilitator more than the process itself which does speak to pedagogy approach being a stronger motivator for most learners rather than gamification or andragogy (Ozuah, 2005).

Freeman & Freeman (2013) indicated in their research that gamification leads to a sense of fulfilment in the learning process which was picked up by interviewing one of the candidates who stated it was more important to them to learn than complete the goals given.

To understand if the study had applied gamification elements correctly which Johnson, Garrison, Hernez-Broome, Fleenor, & Steed (2012) noted as critical to avoid wastage of resources and costs if not done correctly, thus the following steps will be reviewed in conjunction with the results of the study.

The first step in gamification looked at understanding the target audience and the context (Marache-Francisco & Brangier, 2013), the target audience was considered as given in terms of

the GIBS session, the context was tested in terms of the interview questions to the candidates in terms of relevance as well as the survey of the forty learners in the class, the results indicated that exposure was prevalent as well as the twelve interviewed candidates themselves noted relevance in their context.

The second step in gamification considered what the learning objectives where in terms of delivery outcomes (Marache-Francisco & Brangier, 2013). The candidates themselves were not aware of the intended delivery outputs, being the five skills, but instead considered it learning how to programme a robot with a test, the programmable competitive race, at the end. This also was proven as ten candidates that were interviewed felt that they were able to apply what they had learnt through the session to the test at the end. This supports the outcome of this step which notes that it has to be meaningful and have positive consequences (Marache-Francisco & Brangier, 2013) for the candidates, which each step guided them to make the robot do something before they could proceed to the competitive race at the end.

The third step in gamification related to how the experience was structured to meet specific learning objectives. This had to allow freedom to get to outcomes as well as specific learning objectives that had to be met (Marache-Francisco & Brangier, 2013). We saw this as part of the survey results gave feedback on each of the future skills that most of the candidates noted they felt they were exposed to.

The fourth step in ensuring a successful gamification process was to see if it was possible to create a gamified process applying all the components with the resources available (Marache-Francisco & Brangier, 2013). This was measured through candidates responses in the interviews if they found they were motivated to participate of which nine candidates felt motivated to participate and eight had found it fun to partake in.

The final step in gamification related to application of the self-element which saw learners needing to complete actions in a non-competitive way and a social-element which considered team dynamics whether through a competitive or co-operative approach (Huang & Soman, 2013). Both of these we saw with the candidates that were interviewed, from a self-element we saw the candidates completing the scenarios given to them, specifically noted by seven candidates who kept persisting to complete tasks given to them even if it was seen as difficult. From the social-element was saw the competitive component at the end of the lesson with ten candidates noting its application to what was learnt during the session as well as the co-

operative component which saw five candidates noting in the interviews to be driven through team effort.

6.2.4. Human-Robot Interface Exposure

The intent of using HRI in the study was to understand if it would act as a further motivator. The reason for this is that robots have been more accepted by humans compared to, say an e-learning platform and requires little motivation to start using it according to the research done by Young (2017), simply because association is made with it and it is seen as more tangible in terms of it being a physical object and provides direct feedback which falls in line with one of the principles in andragogy (Knowles, 1996).

One candidate interviewed noted how easy it was while another three noted that it was an indication of where the future was going and how it would impact their jobs one day. Zenk, Crowell, Villano, & Diehl (2017) tested in their research if it was possible to get adoption of the use of robotics with non-technical students and they had seen this occur in a positive way.

As part of this study, the same adoption has been seen, ten of the twelve candidates interviewed found they had benefited from the technique, whether it was through new skills or just the technique being applied. Of the twelve candidates only two had some form of programming background and those two also considered the technique using HRI beneficial due to the tangibility of the outcomes

Due to HRI being a relatively new field in education it is noted that it has to have clear objectives to ensure success (Montebelli, Billing, Lindblom, & Dahlberg, 2017). Referring to the competition component at the end of the workshop, it had required that all candidates complete the required lessons to progress to that point. This the ten of the candidates interviewed confirmed they had applied what they had learnt from the previous tasks provided to lead up to the point of the competitive race. It supports that the learning of a topic by applying it physically to something else, or "teaching" the robot itself to carry out tasks creates knowledge transfer itself and also aligns to research done by Tanaka & Matsuzoe (2012) though in their case it was applied to children and not adults.

The intent was to transfer a set of future skills that was not made mention to the candidates during the session, this was also seen as positive as noted before as it allowed the ability to transfer non-technical skills which helps build on the possibilities of research and practical knowledge transfer using HRI (Bravo, González, & González, 2017).

Another inference of HRI is that it exposed people to the potential of technology and what it can do (Young, 2017) and has in cases seen students having no interest in it before exposure to suddenly being more mindful around its potential (Zenk, Crowell, Villano, & Diehl, 2017). This was observed with many of the candidates interviewed, one noting that they had a complete change of heart around what technology is capable of and looked at implementing changes using technology as a product owner at their offices. Whereas others found interest in other areas, one candidate considering taking up programming to implement new capabilities in their team while another explored the financial technology or "Fintech" world to stay abreast of what was changing but overall ten candidates found it relevant to change and important which they would not have done so prior to the session unless exposed to the simplicity of it.

One candidate interviewed noted that they were afraid of technology but it actually drove them to want to succeed, this Zenk, Crowell, Villano, & Diehl (2017) noted in their research when HRI was applied to autistic children it had the same results, seeing a reduction in anxiet and thus aiding the learning process.

Also in another instance a candidate interviewed noted in their environment a family member that is studying biochemistry had also been exposed to robotics through application of that subject to solve a real world problem which was inline with one of the cases provided by Blain, Ferworn, Li, Tran, & Carter (2017) relating to th archeology students using robots to solve their final exam at a simulated dig site. This furterh supports the practical scenarios applied in the GIBS session which also used a problem centred approach with HRI to solve a specific problem supporting one of the andragogy principles for adult learning (Knowles, 1996).

6.2.5. Summary of Discussion for Research Question 1

To revisit what research question one had set out to understand:

Can one design a module using andragogy principles, gamification and HRI to teach the skills required for the future?
The intent was to understand if application of these framework together would have lead to knowledge transfer in the session itself.

Looking at each element separately to understand if that was the case, with andragogy it was found the candidates been exposed to the principles noted by Michael Knowles, namely self-directed learning, problem centred design of approach and finally learn through failure

(Knowles, 1996). It was also noted that there were assumptions linked to andragogy theory which had mostly all surfaced during the interviews being noted by the candidates themselves.

The second element was gamification, this was intended to act as a motivator and ensure both components of self-elements and social-elements, through co-operation or competition, would have surfaced during the exercises and assist in driving participation in the workshops themselves (Huang & Soman, 2013). This was also evident in the interviews and findings through the results.

The third element was the transport layer which was used as a tangible component to physically deliver the lesson and was intended to be used as the non-conventional, experiential learning mechanism namely HRI (Bravo, González, & González, 2017). This the candidates embraced also as it was noted that it opened up their eyes to new possibilities and reducing fear and anxiety. This was also seen in the case from Wilson, Calongne, & Henderson (2015) using gamification and online technology seeing a reduction in fear and anxiety in a similar manner. Further to this finding it is also noted that it helped as a motivational accelerated (Young, 2017) to support gamification to deliver the content required.

Finally the content itself which was intended to be transferred during the workshop, the five skills, critical thinking, complex problem solving, people management, collaboration and creativity (Gray, 2016). This the survey had proven post the GIBS sessions that most candidates had felt they were exposed to the five skills this was further supported again by the candidates that were interviewed as mostly being successfully applied, with collaboration as the highest skill at eleven candidates supporting this, followed closely by critical thinking with ten candidates supporting this, then complex problem solving with nine candidates supporting and finally people management and creativity both with eight candidates supporting that they had been exposed to these skills. In all cases a majority had supported the view that they felt they had been exposed to the skills that had been intended to be transferred during the workshop.

Thus all objectives to meet to the outcome required to answer the first research question proving a basis that the framework had met the capability to apply knowledge transfer to adult learners using gamification and HRI underpinned with Andragogy principles.

Now that we know the intervention was successful it is important to understand if the knowledge transfer had resulted in a sustainable reduction in the knowledge to action gap.

6.3. Discussion of Research Question 2:

Owing to the module designed in phase one being successful would it enable retention of the skills that were transferred?

This research question was addressing the need to understand if such interventions, which had now been proven successful in knowledge transfer, where able to ensure that the knowledge being transferred changed into sustainable actions and not lost post the session. As part of the study seven themes emerged from the nine interviewed candidates who had noted such a change versus the three that hadn't noticed any change. The sections below will address these findings and align them with the supporting literature to help understand them better.

6.3.1. Theme 1: Collaborations to find Solutions

The first theme of collaboration seemed to be the most prevalent from the session as eight candidates had noted that they felt they had started applying this skill differently since the session. Lindeke & Sieckert (2005) indicated that the skill of collaboration related to parties finding consensus on specific views and topics and in the case of this study there were teams of individuals from different companies that would need to find ways to work together to be able to compete against the other teams.

This further supports gamification principles noted by Huang & Soman (2013) which required there to be elements of cooperative work to ensure successful engagement of the gamification model. Further to this the problem centred approach which forced cooperation amongst teams and been brought about by the design of the GIBS session and had ensured that one of the principles of Andragogy was also present. The dynamics principle of the gamification theory supports this as well by ensuring interaction with learners and how they could achieve the outcomes of their strategies (Robson, Plangger, Kietzmann, & McCarthy, 2015).

Finally this was seen in the case from Bravo, González, & González (2017) where HRI was used to transfer skills to drama students as part of learning process. This had given the students instant feedback as part of their process and generating a sense of collaboration with the robot itself. In the end they saw an increase in collaboration in that case and this is potentially a reinforcing factor why in this study there was also higher number of candidates noting increased collaboration and longer term adoption of this skill compared to the other skills.

Thus for this theme all areas, gamification, HRI and andragogy, had leant itself to support the emergence of it in the candidates that had noted successful knowledge to action transition.

6.3.2. Theme 2: Fun to learn

The second theme that emerged from the nine interviewed candidates that noted successful conversion of the knowledge to action was that they all indicated it was a fun way of learning, creating a sense of motivation participate in the exercises and help others to as well.

This supports one of the principles of gamification which intends to assist in creating a fun factor as part of the design through rewards and cooperative and competitive play (Huang & Soman, 2013). This is further supported by the research done by Robson, Plangger, Kietzmann, & McCarthy (2015) in that the emotions infered through gamification such ,as fun, can help motivate learning and support adoption of content.

To reinforce these emotions HCI and HRI platforms can be used to create emotion due to the outcomes of the technology platforms, this was done as part of research to see if emotions could be induced (Hibbeln, Jenkins, Schneider, Valacich, & Weinmann, 2017). In the case of HRI the feedback was instant as to what the learners had to do as part of their tasks thus enabling to quickly see if they had achieved the outcome or not by making the robot execute on their designed tasks. This even supported faster learning through the "learn by doing" approach which Tanaka & Matsuzoe (2012) applied as part of their HRI studies with learners adopting their language skills by training their robot.

This is further supported by the principle of failure through the learning process (Carmeli, Gelbard, & Reiter-Palmon, 2013), as the robots feedback directly and as noted the users know if they have succeed or not.

6.3.3. Theme 3: Relevance in a Changing World(VUCA)

As part of this theme, eight of the nine candidates interviewed had indicated an impact in terms of their perception changing on how the world was changing. Due to the introduction of HRI into the learning process it was noted by the candidates to how the world was evolving with technology.

It also was noted that it created a new sense of interest in technology and what was all possible, similar to the findings the research done by Zenk, Crowell, Villano, & Diehl (2017) where non-technical students who had ,no exposure prior to robotics or interest in it, found themselves

more interested in the field itself and were interested to explore it further and take up technical skills.

This was further supported by the third principle in gamification which supported emotional state change (Robson, Plangger, Kietzmann, & McCarthy, 2015), understanding that the world was changing in their lives and it was something to accept and change within their own lives.

O'Toole & Essex (2012) supported this as well with the third prinicple in andragogy which saw adult learners needed to find relevance of learning to their own lives to be able to successfully apply the learning. This was done through the application of HRI and showing the learnings,as noted above, that the world was changing and their need to consider new skills could not be ignored due to the VUCA environment (Bennett & Lemoine, 2014).

6.3.4. Theme 4: Continuous Learning

The fourth theme that emerged from eight of the candidates was that they would take on new learning's which they had never intended to do prior to the workshop. Though this was not limited to one specific field of learning, it ranged from programming to general management.

Ozuah (2005) noted in their research that within andragogy continuous learning was more prevelant compared to pedagogy. This becomes more important in terms of corporate leadership development as well as it is critical to stay ahead for both the sake of business as well as individuals as new skills are created through future technologies (Bennett & Lemoine, 2014; Salas, Tannenbaum, Kraiger, & Smith-Jentsch, 2012).

Though this is not clear as part of one of the gamification principles, the rewards portion created by gamification in the case of the Deliotte learning academy saw increase in employees wanting to take on new learning's (Huang & Soman, 2013) but this was within the corporate and not external to it. Also there is no indication from an HRI perspective besides cases that saw candidates increasing more interest in a technological field which was not the case in all the candidates.

6.3.5. Theme 5: Direct Application at Work

The fifth theme emerged from seven of the candidates interviewed, this related to them applying what they learnt at work in terms of new solutions or attending to things differently to help their colleagues.

The approach used in the session was a problem centred one which was supported by Knowles (1996) to be able to ensure learning could be related to the candidates current environment

which was also supported by Taylor & Kroth (2009) indicating it assisted in ensuring candidates where engaged. This further seemed to enable learners take these transferred skills as relevant to their working environments, which also one of principles of andragogy, relevance to learners environment (Knowles, 1996).

From an HRI perspective Zenk, Crowell, Villano, & Diehl (2017) saw adoption of non-technical individuals taking interest in the field of robotics by being exposed to it. We saw this in the findings as some candidates took to technology implementations within their organisations which they had not considered before.

As part of the studies Nelson (2012) had done with gamification and employee motivation they had found similar findings to what we had found in terms of exposure to gamification had driven interest in employees to participate more in what they did through the creation of self-expression and viewing things in a different perspective.

6.3.6. Theme 6: Competitive Element

It was discovered in six of the nine candidates that they showed very strong competitive behaviour in the session itself. This is one of the elements which ties strongly to what gamification does look at providing as part of its emotions principles which sees learns invoke this trait due to the nature of how the scenarios of the lessons are setup (Huang & Soman, 2013).

This Ibanez, Di-Serio, & Delgado-Kloos (2014) had found as part of their research drove up learning participation but was also seen as a risk as what Hamari, Koivisto, & Sarsa (2014) noted could drive negative emotions as well which we did see in one of the six candidates who were interviewed who decided themselves to rather not partake in the last competitive element of the session.

This falls in line with the learn through failure,one of the andragogy principles (Carmeli, Gelbard, & Reiter-Palmon, 2013), as the same candidate indicated that they had taken the learning and applied it afterwards.

HRI has only used competitive elements as part of exams for students, such as the BUSA Dig case (Blain, Ferworn, Li, Tran, & Carter, 2017), but it did show increased motivation as well but this would most likely have been attributed to the gamification factorson how the approach was setup rather than HRI itself.

6.3.7. Theme 7: Taken out of Comfort Zone

The last theme had emerged only from five candidates of the nine candidates but it was enough to consider as a theme as it was not explored as in depth and had emerged through the interviews themselves. This was specifically relating to exposure of programming as well as the robotics or technology component.

It was found that out of the nine candidates, two had noted they had already exposure to programming and for them it was not to difficult, however of the remaining seven, the five that noted they had never done programming before also said they had felt that it was something they would never do in their lives. Most of the cases we reviewed around HRI had seen non-technical candidates who had never been exposed to robotics or programming taking a different stance to it post their exposure to it, examples of the drama students (Bravo, González, & González, 2017), the BUSA Dig with the archaeologists (Blain, Ferworn, Li, Tran, & Carter, 2017) and some of the teaching of students with autism new skills such as those done by Zenk, Crowell, Villano, & Diehl, (2017) which saw in all scenarios students adopting the area of technology post the interventions.

One candidate had a fear of technology but she had felt it motivated her to progress rather than sit back, this can be supported by the two assumptions andragogy makes about adult learners, one that they have a motivation to learn and another that they have a need to know (Taylor & Kroth, 2009). This was further supported by the last principles of gamification, emotional drive (Robson, Plangger, Kietzmann, & McCarthy, 2015), due to the competitive behaviour that would have pushed the candidate to participate which they appreciated more than they regretted as it helped them take a different view on technology and look at business solutions differently.

6.3.8. Summary of Discussion for Research Question 2

Owing to the module designed in phase one being successful would it enable retention of the skills that were transferred?

The intent of this question was to understand if there was a sustainable transfer of knowledge that had reduced the knowledge to action gap. We had seen multiple themes emerged from the nine candidates who did in fact indicate this change.

Of the seven themes, four themes emerged with most of the candidates supporting it, these where:

- Collaboration to find a solution
- Fun to Learn
- Relevance in a changing world(VUCA)
- Continuous Learning

They all had attributes of the theories of Gamification, Andragogy and HRI, except continuous learning which only had attributes of andragogy.

The remaining themes which were less prevalent in all candidates was:
- Direct Application to Work
- Competitive Element
- Taken out of Comfort Zone

Of these only Competitive Element didn't have all theory attributes as it only had Andragogy and Gamification.

As part of these findings it was possible to answer the question that the base framework that was developed as part of phase one was able to deliver the results required as part of the phase two study, indicating the that framework could reduce the knowledge to action gap through a single session of exposure using these techniques.

This lead to the model for this framework:
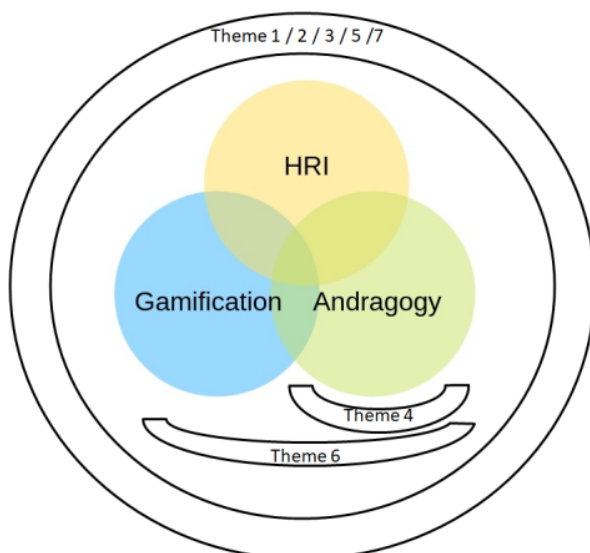
Figure 7:Gamification / HRI / Andragogy Framework

Table 5: Framework Themes

Theme	Aligns to:
1. Collaboration to find Solutions	Andragogy / HRI / Gamification
2. Fun to Learn	Andragogy / HRI / Gamification
3. Relevance in a Changing World(VUCA)	Andragogy / HRI / Gamification
4. Continuous Learning	Andragogy
5. Direct Application at Work	Andragogy / HRI / Gamification
6. Competitive Element	Andragogy / Gamification
7. Taken out of Comfort Zone	Andragogy / HRI / Gamification

6.4. Conclusion of Discussion of Results:

This chapter had considered looking at the literature behind the findings, it had looked at the candidates' responses to the questions as well as what literature had supported. The intent of this was to understand had the two research questions been answered and was there any findings that had disproven past literature that had been written on the topics of gamification, andragogy and HRI.

There was alignment to past literature of these different frameworks and by combining them the study showed that there was potential in using these techniques collaboratively to achieve a change in a learner's behaviour to achieve a goal. These results were positive and could be built on in future to understand potential focused approaches to using these combined techniques.

The next and final chapter will explore implications of these finds to future research and management as well as what the limitations of the research was which should be considered for future initiatives looking at similar approaches.

Chapter 7: Recommendations

7.1. Introduction to Recommendations:

This study had set out to understand if utilisation of HRI with gamification applied through the principles of andragogy would reduce the knowledge to action gap. This was important to understand as traditional teaching methods are not sustainable for the rate of change in the business environment (Liebhart & Lorenzo, 2014) to prepare both learners as well as employees for changes in their environments and be able to look at accelerated learning and teaching techniques for knowledge transfer and reduction of the knowledge to action gap.

This was also seen even more so as a need as candidates leaving educational institutions were not always at the level organisations needed them to be at (Davies M. , 2013) to ensure execution of their tasks as well as supporting growth of the organisation in a competitive way. To that extent it was noted that consideration should be given to test experiential learning techniques to see if there were methods available to do accelerated knowledge transfer (Montebelli, Billing, Lindblom, & Dahlberg, 2017) which HRI was chosen to be used with known methods used in education such as gamification.

This chapter looks at the summary of findings of this study to make a final conclusion and recommendation of what has been discovered and how it applies both to research as well as business.

7.2. Principal findings:

The findings related to answering two questions to see if the study could support the technique discussed.

The first question considered, *Can one design a module using andragogy principles, gamification and HRI to teach the skills required for the future?*

The results of the findings supported the outcomes in a positive way by applying the principles of andragogy successfully. To align with what andragogy covered as part of Michael Knowles' framework (Knowles, 1996) there were four main principles of which we adopted three, the first which candidates proved was being met was learning through failure, as noted in research done by Carmeli, Gelbard, & Reiter-Palmon (2013) which was noted by the quick feedback provided by HRI technology (Tanaka & Matsuzoe, 2012).

The second principle was problem centred approach (Knowles, 1996), this was proven especially in the discussions around the competitive components which was required as a motivational factor supported by the design of gamification (Marache-Francisco & Brangier, 2013) which brought in competitive and co-operative elements.

The third principle required learning to be relevant to the learners, this the candidates strongly supported and it aligned with "in the moment" learning (O'Toole & Essex, 2012) which required candidates to apply directly what they theoretically learnt and not have to wait for a later date for application. This HRI further supported as candidates stated that it had opened up their minds as to how the world was changing and how easy technology had become aligning with the findings from Young (2017).

There was a need that elements of motivation had also to be applied which was done through self directed and cooperative and as well as competitive approaches in the design which was supported both the research done by Sogunro (2015) which stated the the learning process itself would lead to motivation of individuals as well as the application of the competitive and cooperative elements from gamification to support the motivational factors even further (Huang & Soman, 2013).

This further created a platform as noted by Young (2017) to understand if HRI is actually more accepted than other technologies in terms of experiential knowledge transfer and applying it other techniques to see if it does create a sense of motivation to use it which was the case as the candidates stated both motivation base on what they had found by using the technology with instant feedback and exploration through a form of creativity.

This helped create a point to understand if using gamification through application to HRI for education and learning had built on areas of research that have not been explored as in depth to see if it does have a positive outcome (Montebelli, Billing, Lindblom, & Dahlberg, 2017). This was found to be the case and results in terms of motivation where strongly supported by most candidates.

Understanding that the techniques had provided strong feedback in a positive direction, the content of knowledge that was intended to be transferred, namely the five skills being collaboration, people management, creativity, complex problem solving and critical thinking, had all proven positive by majority of the candidates both in the classroom survey of the forty candidates as well as the phase two reflections with the twelve candidates that were interviewed.

Finally this added to provide answers to the research which Liu, Santhanam, & Webster (2017) had done relating to that application of gamification needed to be tested more with information technology platforms as it was a gap. Also the field of HRI was a gap in terms of education which needed to be explored further which this aids with (Montebelli, Billing, Lindblom, & Dahlberg, 2017).

Thus all evidence in the study presented had proven that it was possible to design a module using andragogy principles supported by gamification and HRI to teach skills required for the future.

The second question considered *Owing to the module designed in phase one being successful would it enable retention of the skills that were transferred?*

Acknowledgement of the skills being applied due to the attendance of the GIBS session as noted in phase one was prevalent nine of the twelve candidates interviewed nine months later. This supported the view that the session wasn't seen as a novelty which Han (2010) noted as a potential risk. The interviews highlighted seven major themes that support most of the three theories which were then derived into a formal framework as seen below:
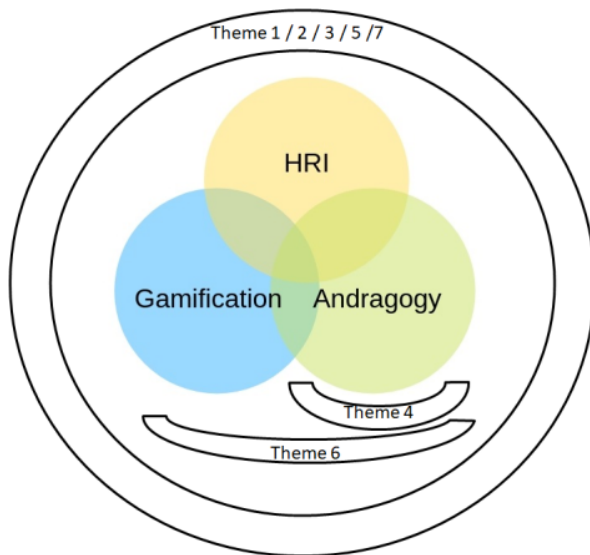

Figure 8: Gamification / HRI / Andragogy Framework

These themes were supported by the cases both found the literature from the gamification as well as the HRI theories. All of which strongly underpinned by Andragogy to ensure both the

assumptions and principles provided by Michael Knowles (Knowles, 1996) where still applicable in the findings that we had put forward.

Looking at the research from Salas, Tannenbaum, Kraiger, & Smith-Jentsch (2012) which discussed the need for continouos learning to be embedded in to leadership and individuals, further supported by Sun & Fan (2017) who mentioned in their research that spillover of new skills occurs while technology evolves, both supporting the need for continous learning to stay relevant. The themes strongly support these needs and further enabled the possiblities to use them to be able to transfer knowledge that would be sustainable in an accelerated way.

Finally this supported the research done by Ward, Smith, House, & Hamer (2012),noting a call to action and a behaviour change in the candidates proving it was possible to test for skills transfer.

Thus it was possible to design the intervention using this framework to transfer skills that would be actionable by the candidates.

7.3. Implications for management:

The study has noted many findings which can be applied by business managers to help close the gap in terms of how they approach innovation as well as provide skills transfer in a potentially more motivated and practical manner.

Learners using this method would be able to take on skills in a shorter period of time, though it was only tested on five skills it could be focused to allow learners to gain the practical knowledge supported by theory and able to apply it in a shorter space of time. This would enable learners to up skill quicker if they found they had gaps and not necessarily the time to spend on long courses.

The training course designers would be able to apply more fun elements with hands on deliver methods to ensure full participation of all members and support returning candidates by encouraging candidates to start looking a keeping their skills up to scratch through continuous learning.

Facilitators of sessions would have the benefit of having a more engaged group of students and allowing them to be more flexible in their engagements by using these elements to help transfer knowledge in their classes.

For business managers and corporate education managers have the ability to align employees to goal changes that require new skill sets including behaviour changes in a more accelerated pace versus traditional methods. This also gives them more options to customise their offerings to their employees through scenario design of gamification and simulations of HRI.

Finally as organisations as a whole and educational institutions this give a better way of promoting a continuous learning culture for both new candidates and employees as well current employees and returning students.

7.4. Limitations of the research:

One of the limitations of the research was that it was only done in a specific industry sector and had run over only a specific set of gamified scenarios using human-robot Interaction.
This means that there is potential of a different outcome or finding, in for example a purely technical or technological sector, but this was the reason more than one principle was combined to allow for robust coverage of the different principles focused on delivering on the reduction of the knowledge to action gap.

Another limitation was noted in that it was a small sample size that was used thus runs the risk of generalisation, specifically due to the fact that it was management that was the focus of this study and not other levels of individuals within the sector that was interviewed.

Further to that, the researcher is at risk of bias due to the subjective nature of qualitative research even though all measures were taken to reduce bias.

7.5. Suggestions for future research:

This research was done across multiple skills and had indicated that some skills were adopted by some candidates and others by other candidates, it would be good to understand what the differences could have been by testing only one skill at a time and understanding if there is a cause to the different outcomes or if it is caused by external factors not visible to this research.

The research should also be done in other sectors, including those that are predominantly technology orientated to understand if they would experience the same level of motivation and ability to adopt a different approach to their working environment.

Further to this it should also be tested on individuals who are not in management as well as students in secondary and tertiary education to see if skills transferred to them at an acceptable

level that can be used practically within organisations. Another area to consider as well as tertiary educational institutions so that they could run studies on their subjects to see if they also had positive outputs versus traditional methods using gamification and problem centred HRI and understand if this provides better results.

Also another area to consider is what made some of the themes stronger than others and would it be possible to focus on specific themes to create greater reduction between the knowledge to action gap?

Finally this was tested in an emerging market economy, it would be interesting to understand if the same results would be achieved in a developed economy thus potentially finding a global model that can be applied. This should be further explored by considering culture factors if this also would have an effect on the outcomes which could also be considered as future research.

7.6. Conclusion of Research:

The study had the intent of understand if there were ways to find an accelerated way of transferring new skills sustainably to assist business and employees alike in solving for an ever changing environment where new skills are required and the pace of change is not always supported by traditional educational teaching methods.

The quantitative study for phase one had found that the techniques employed through the design of the class module utilising HRI and gamification underpinned by andragogy principles was successful in delivering knowledge transfer. Phase two of the study had set to prove that the proven framework would also reduce the knowledge to action gap which through the interviews majority of the candidates had highlighted this was the case proving the framework as viable for future use of educational module designs.

This had further proven there was an opportunity to apply these learning's and techniques in organisations to accelerate learning as well as the ability to expose employees to different possibilities by taking them through these techniques. Thus laying the foundation for further studies in the area of utilisation of HRI in education and learning processes.

8. References

Azadegan, A., & Riedel, J. c. (2012). Serious Games Integration in Companies: A Research and Application Framework. *2012 12th IEEE International Conference on Advanced Learning Technologies* (pp. 485-487). Nottingham: The Gala network of excellence .

Baker, D. F., & Baker, S. J. (2012). To "Catch the Sparkling Glow": A Canvas for Creativity in the Management Classroom. *Academy of Management Learning & Education Vol. 11, No. 4*, 704-721.

Bennett, N., & Lemoine, J. G. (2014). What a difference a word makes: Understanding threats to performance in a VUCA world. *Business Horizons vol 57*, 311—317.

Bidshahri, R. (2017, July 04). *7 Critical Skills for the Jobs of the Future*. Retrieved from Singularity Hub: https://singularityhub.com/2017/07/04/7-critical-skills-for-the-jobs-of-the-future/#sm.0001nbjf3b8zrfjzr3a13dn8jm1w2

Blain, R., Ferworn, A., Li, J., Tran, J., & Carter, M. (2017). A Multidisciplinary Approach to Learning Human-Robot Interaction (HRI) Through Real-World Problem Solving—The "BUSA Dig" . *Journal of Human-Robot Interaction, Vol. 6, No. 2,*, 70-91.

Boone, H. N., & Boone, D. A. (2012). Analyzing Likert Data. *Journal of Extension,Vol 50*, 1-6.

Boote, D. N., & Beile, P. (2005). Scholars Before Researchers:On the Centrality of the Dissertation Literature Review in Research Preparation. *Educational Researcher, Vol. 34, No. 6*, 3–15.

Brain Drone Race. (2017, December 26). Retrieved from Worlds 1st Brain Drone Race: http://braindronerace.com/

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3:2*, 77-101.

Bravo, F. A., González, A. M., & González, E. (2017). Interactive Drama With Robots for Teaching Non-Technical Subjects. *Journal of Human-Robot Interaction, Vol. 6, No. 2*, 48-69.

Bryman, A., & Bell, E. (2015). *Business Research Methods.* England: Oxford University Press.

Calabretta, G., & Kleinsmann, M. (2017). Technology-driven evolution of design practices: envisioning the role of design in the digital era. *Journal of Marketing Management (33)*, 292–304.

Carmeli, A., Gelbard, R., & Reiter-Palmon, R. (2013). Leadership, creative problem-solving capacity, and creative performance: the importance of knowledge sharing. *Human Resource Management, Vol. 52, No. 1.* , 95–122.

Chamorro-Premuzic, T. (2018). Take Control of Your Learning at Work. *Harvard Business Review*, 1-3.

Coleman, J. (2017). Lifelong Learning Is Good for Your Health, Your Wallet, and Your Social Life. *Harvard Business Review*, 1-2.

Davies, A., Fidler, D., & Gorbis, M. (2011). *Future Work Skills 2020.* Palo Alto, CA: Institute for the Future for University of Phoenix Research Institute.

Davies, M. (2013). Critical thinking and the disciplines reconsidered. *Higher Education Research & Development 32:4*, 529-544.

Domínguez, A., Saenz-de-Navarrete, J., de-Marcos, L., Fernández-Sanz, L., Pagés, C., & Martínez-Herráiz, J.-J. (2013). Gamifying learning experiences: Practical implications and outcomes. *Computers & Education 63*, 380–392.

Erenli, K. (2013). The Impact of Gamification - Recommending Education Scenarios. *International Journal of Emerging Technologies in Learning(iJET) – Volume 8, Special Issue 1*, 15-21.

Eseryel, D., Law, V., Ifenthaler, D., Ge, X., & Miller, R. (2014). An Investigation of the Interrelationships between Motivation, Engagement,and Complex Problem Solving in Game-based Learning. *Educational Technology & Society, 17 (1)*, 42-53.

Field, B., Booth, A., Ilott, I., & Gerrish, K. (2014). Using the Knowledge to Action Framework in practice: a citation analysis and systematic review. *Implementation Science,9:172*, 1-14.

Freeman, M., & Freeman, A. (2013). The game of information systems higher education. *Faculty of Engineering and Information Sciences - Part A*, 1-14.

Gray, A. (2016, January 16). *The 10 skills you need to thrive in the Fourth Industrial Revolution* . Retrieved from World Economic Forum: https://www.weforum.org/agenda/2016/01/the-10-skills-you-need-to-thrive-in-the-fourth-industrial-revolution/

Greiff, S., Wustenberg, S., Holt, D., Goldhammer, F., & Funke, J. (2013). Computer-based assessment of Complex Problem Solving: concept, implementation, and application. *Education Tech Research Dev 61*, 407–421.

Gresse, L. (2017, August 1). *The important of People Management in today's world.* Retrieved from Ubuhlehr: http://ubuhlehr.co.za/2017/08/01/importance-people-management-todays-world/

Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does Gamification Work? — A Literature Review of Empirical Studies on Gamification. *47th Hawaii International Conference on System Science* (pp. 3025-3034). Hawaii : IEEE Computer Society.

Han, J. (2010). Robot-Aided Learning and r-Learning Services. In D. Chugo, *Human-Robot Interaction* (pp. 247-266). Rijeka, Croatia: InTech.

Hibbeln, M., Jenkins, J., Schneider, C., Valacich, J., & Weinmann, M. (2017). How is your user feeling? Inferring emotion through human-computer interaction devices. *MIS Quarterly Vol. 41 No. 1,* , 1-21.

Huang, W., & Soman, D. (2013). *A Practitioners Guide to Gamification of Education.* Toronto: Rotman School of Management,University of Toronto.

Ibanez, M.-B., Di-Serio, A., & Delgado-Kloos, C. (2014). Gamification for Engaging Computer Science Students in Learning Activities: A Case Study. *IEEE Transactions on Learning Technologies, Vol. 7, No. 3*, 291-301.

Institute for the Future. (2018, April 8th). *People + Technology Research Collection*. Retrieved from Institute for the Future: http://www.iftf.org/our-work/people-technology/

Jackson, D. (2013). Business graduate employability – where are we going wrong? *Higher Education Research and Development, 32(5)*, 776-790.

Johnson, S. K., Garrison, L. L., Hernez-Broome, G., Fleenor, J. W., & Steed, J. I. (2012). Go For the Goal(s): Relationship Between Goal Setting and Transfer of Training Following Leadership Development. *Academy of Management Learning & Education Vol. 11. No. 4.* , 555-569.

Joshi, A., Kale, S., Chandel, S., & Pal, D. K. (2015). Likert Scale: Explored and Explained. *British Journal of Applied Science & Technology,7(4):* , 396-403.

Knowles, M. (1996). Andragogy: an emerging technology for adult learning. In M. Knowles, *The Modern Practice of Adult Education: From Pedagogy* (p. Section 2.1). London, U.K: Cambridge Book Company.

Liebhart, M., & Lorenzo, L. G. (2014). Between planned and emergent change: decision maker's perceptions of managing change in organisations. *International journal of knowledge, culture and change management, 10 (5).*, 214-225.

Lindeke, L., & Sieckert, A. (2005). Nurse-Physician Workplace Collaboration. *Online Journal Issues Nursing 10(1)*, 1-7.

Liu, D., Santhanam, R., & Webster, J. (2017). Toward meaningful engagement: A framework for design and research of gamified information systems. *MIS Quarterly Vol. 41 No. 4*, 1011-1034.

Lubner, M. (2017, November 7). *Opinion: How we can fix south africas skills development crisis*. Retrieved from IOL Business Report: https://www.iol.co.za/business-report/opinion/opinion-how-we-can-fix-south-africas-skills-development-crisis-11891803

Marache-Francisco, C., & Brangier, E. (2013). Process of Gamification: From The Consideration of Gamification To Its Practical Implementation. *CENTRIC 2013 : The Sixth International Conference on Advances in Human-oriented and Personalized Mechanisms, Technologies, and Services* (pp. 126-131). Metz, France: IARIA.

McCrae, R. R., Costa, P. T., de Lima, M. P., Simões, A., Ostendorf, F., Angleitner, A., . . . Piedmont, R. L. (1999). Age differences in personality across the adult life span: Parallels in five cultures. *Developmental Psychology, Vol 35(2)*, 466-477.

Merriam, S. (2001). Andragogy and Self-Directed Learning: Pillars of Adult Learning Theory. *New Directions For Adult and Continuing Education no .89*, 1-13.

Mngomezulu, S. (2017, June 30). *Leadership development essential to give hope to youth*. Retrieved from IOL Business Report: https://www.iol.co.za/business-report/leadership-development-essential-to-give-hope-to-youth-10073088

Montebelli, A., Billing, E., Lindblom, J., & Dahlberg, G. M. (2017). Reframing HRI Education: A Dialogic Reformulation of HRI Education to Promote Diverse Thinking and Scientific Progress. *Journal of Human-Robot Interaction, Vol. 6, No. 2*, 3-26.

Nelson, M. J. (2012). Soviet and American Precursors to the Gamification of Work. *MindTrek 2012,* .

O'Toole, S., & Essex, B. (2012). The adult learner may really be a neglected species. *Australian Journal of Adult Learning,Volume 52, Number 1*, 183-191.

Ozuah, P. (2005). First, There Was Pedagogy And Then Came Andragogy. *Einstein J. Biol. Med.21*, 83-97.

Roberson, D. N. (2002). Andragogy in Color. *Educational Resource Information Center*, 1-11.

Robson, K., Plangger, K., Kietzmann, J. H., & McCarthy, I. (2015). Is it all a game? Understanding the principles of gamification. *Business Horizons Vol. 58*, 411—420.

Roth, S., Schneckenberg, D., & Tsai, C.-W. (2015). The Ludic Drive as Innovation Driver: Introduction to the Gamification of Innovation. *Creativity and Innovation Management, Vol. 24, Iss. 2,* , 300-306.

Rothes, A., Lemos, M. S., & Gonçalves, T. (2014). Motives and beliefs of learners enrolled in adult education. *Social and Behavioral Sciences Vol. 112*, 939 – 948 .

Rouse, M. (2018, July 30). *TechTarget: What Is*. Retrieved from TechTarget: https://whatis.techtarget.com/definition/brain-computer-interface-BCI

Salas, E., Tannenbaum, S. I., Kraiger, K., & Smith-Jentsch, K. A. (2012). The Science of Training and Development in Organizations: What Matters in Practice. *Psychological Science in the Public Interest 13(2)* , 74–101.

Saunders, M., & Lewis, P. (2012). *Doing research in business & management.* England: Pearson.

Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research methods for Business Students Fifth Edition.* England: Pearson Education.

Seaborn, K., & Fels, D. I. (2015). Gamification in theory and action:A survey. *International Journal Human-Computer Studies vol.74*, 14–31.

Sogunro, O. (2015). Motivating Factors for Adult Learners in Higher Education. *International Journal of Higher Education Vol. 4, No. 1*, 22-37.

Sun, Y., & Fan, P. (2017, March 6). Technology spillover. *The International Encyclopedia of Geography*, pp. 1-3.

Tamborini, C. R., Kim, C., & Sakamoto, A. (2015). Education and Lifetime Earnings in the United States. *Demography, 52(4)*, 1383–1407.

Tanaka, F., & Matsuzoe, S. (2012). Children Teach a Care-Receiving Robot to Promote Their Learning: Field Experiments in a Classroom for Vocabulary Learning. *Journal of Human-Robot Interaction, Vol. 1, No. 1*, 78-95.

Taylor, B., & Kroth, M. (2009). A single conversation with a wise man is better than ten years of study: A model for testing methodologies for pedagogy or andragogy. *Journal of the Scholarship of Teaching and Learning, Vol. 9, No. 2*, 42–56.

Ward, V., House, A., & Hamer, S. (2009). Developing a framework for transferring knowledge into action: a thematic analysis of the literature. *Journal of Health Services Research & Policy,Vol.14(3)*, 156-164.

Ward, V., Smith, S., House, A., & Hamer, S. (2012). Exploring knowledge exchange: a useful framework for practice and policy. *Social Science and Medicine, 74 (3)*, 297 -304.

Wilson, D., Calongne, C., & Henderson, B. (2015). Gamification Challenges and a Case Study in Online Learning. *Internet Learning: Vol. 4: Iss. 2, Article 8.*, 84-102.

World Economic Forum. (2018, April 21). *The Future of Jobs*. Retrieved September 13, 2017, from World Economic Forum: https://www.weforum.org/reports/the-future-of-jobs

Young, J. E. (2017). An HRI Graduate Course for Exposing Technologists to the Importance of Considering Social Aspects of Technology. *Journal of Human-Robot Interaction, Vol. 6, No. 2*, 27-47.

Zenk, J., Crowell, C. R., Villano, M., & Diehl, J. J. (2017). Unconventional Students in HRI Education: A Review of Two Initiatives. *Journal of Human-Robot Interaction, Vol. 6, No. 2*, 92-110.

Nr	Code	Code Groups
1	Collaboration - Negative	FutureSkill-Collaboration
2	Collaboration - Positive	FutureSkill-Collaboration
3	Collaboration - Problem resolution through outside team	FutureSkill-Collaboration
4	Collaboration - Robot Sharing in Turns	FutureSkill-Collaboration
5	Collaboration - Seeing others gain knowledge	FutureSkill-Collaboration
6	Complex Problem Solving - First time Coding scenarios	FutureSkill-Complex Problem Solving
7	Complex Problem Solving - Negative	FutureSkill-Complex Problem Solving
8	Complex Problem Solving - Positive	FutureSkill-Complex Problem Solving
9	Complex Problem Solving - Positive - Opinion	FutureSkill-Complex Problem Solving
10	Creativity - More than one solution	FutureSkill-Creativity
11	Creativity - Negative	FutureSkill-Creativity
12	Creativity - Positive	FutureSkill-Creativity
13	Creativity - Positive - Opinion	FutureSkill-Creativity
14	Creativity - Test at the end had multiple potential outcomes	FutureSkill-Creativity
15	Critical Thinking - Came through a Test at the end	FutureSkill-Critical Thinking
16	Critical Thinking - Generated by Code Scenarios	FutureSkill-Critical Thinking
17	Critical Thinking - Limited, not relevant to industry	FutureSkill-Critical Thinking
18	Critical Thinking - Negative	FutureSkill-Critical Thinking
19	Critical Thinking - Opened up mind to technology back at the office	FutureSkill-Critical Thinking
20	Critical Thinking - Positive	FutureSkill-Critical Thinking
21	Critical Thinking - Potential	FutureSkill-Critical Thinking
22	Fun to Learn	Game-Motivation
23	Gamification with HCI	HRI-Influence Motivational State Game-Motivation
24	Keep Trying post Failure - fear of technology	Andr-Principle 2: Learner experience through failure
25	Keep Trying post Failure - Individual	Andr-Principle 2: Learner experience through failure
26	Keep Trying Post Failure - Negative	Andr-Principle 2: Learner experience through failure

27	Keep Trying post Failure - Not about success about what you take away	Andr-Principle 2: Learner experience through failure
28	Keep Trying post Failure - Team	Andr-Principle 2: Learner experience through failure
29	Keep trying post failure -Until frustrated	Andr-Principle 2: Learner experience through failure
30	Motivated - Beginning took a while to get into it	Game-Motivation
31	Motivated - Group Pressure	Game-Motivation
32	Motivated - Level of Excitement	Game-Motivation
33	Motivated - Negative	Game-Motivation
34	Motivated - Noveltyof Tech exposure	Game-Motivation
35	Motivated - Positive	Game-Motivation
36	Motivated - Through others learning	Game-Motivation
37	Motivated by coding scenarios	Game-Motivation
38	Motivated by the Facilitator - Pedagogy	Game-Motivation
39	Motivation through Collaboration	Game-Motivation
40	Opening your mind to alternatives	Learnings beyond expected
41	Overcame fear of scenarios through teamwork	Game-Participation
42	Past Coding Experience	Andr-Principle 3: Relevance directly to learners current life as well as impact on their working environment
43	People Management - Alignment Causes Zero application	FutureSkill-People Management
44	People Management - Avoid Frustration due to Knowledge of Solution	FutureSkill-People Management
45	People Management - Negative	FutureSkill-People Management
46	People Management - Positive	FutureSkill-People Management
47	People Management - Simplify problem to get resolution	FutureSkill-People Management
48	Perceived Complex	Andr-Principle 4: Problem centred
49	Persistence caused by complex scenario	Andr-Principle 4: Problem centred
50	Post - Agree to Merge of Business and Tech	Andr-Assumption- Apply in Physical world learning HRI-Application of what was learnt
51	Post - Apply learning to assist company	Andr-Assumption- Apply in Physical world learning HRI-Application of what was learnt
52	Post - Benefit - Big Impact - Open to new concepts	Benefit

53	Post - Benefited from Technique	Benefit
54	Post - Change Subconsciously Happened	Learnings beyond expected
55	Post - Collaboration - Partnering to find solutions	FutureSkills Adopted
56	Post - Collaboration - Positive	FutureSkills Adopted
57	Post - Complex Problem Solving	
58	Post - Confidence to take on new challenges	Learnings beyond expected
59	Post - Creativity Application	FutureSkills Adopted
60	Post - Critical Thinking Application	FutureSkills Adopted
61	Post - Higher expectations of technology	Andr-Assumption- Apply in Physical world learning HRI-Application of what was learnt
62	Post - Interest in understanding Code	HRI-Application of what was learnt
63	Post - Looked at Applying new solutions	Andr-Assumption- Apply in Physical world learning HRI-Application of what was learnt
64	Post - More alert, promote ambition and curiosity	Learnings beyond expected
65	Post - More Thoughtful of Decisions that are made	FutureSkills Adopted
66	Post - New Learning also linked to GIBS course	Learnings beyond expected
67	Post - No Benefit to work or career	Benefit
68	Post - No changes	Benefit
69	Post - No Changes currently continious learner	Motivation for Continious Learning
70	Post - No impact on wanted to learn something new	Motivation for Continious Learning
71	Post - No interest to learn something new	Motivation for Continious Learning
72	Post - Practical Application of Theory	Andr-Assumption- Apply in Physical world learning
73	Post - Problem Solving - Positive	FutureSkills Adopted
74	Post - Problem Solving - Positive - Example	FutureSkills Adopted
75	Post - Robotics not applicable to insurance	HRI-Application of what was learnt
76	Post - Technique don't realise you actually learning	HRI-Application of what was learnt
77	Post - Technique Gamification - Negative	Motivation for Continious Learning
78	Post - Technique Gamification - Positive	Motivation for Continious Learning

79	Post - Technique Robots - Negative	HRI-Application of what was learnt
80	Post - Technique Robots - Positive	HRI-Application of what was learnt
81	Post - Technique sparked interest in future	HRI-Application of what was learnt
82	Post - Try stay now more informed around Tech	Andr-Assumption- Apply in Physical world learning
83	Post - Use Technique Again - Only for Fun	Motivation for Continious Learning
84	Post - Use Technique Again - Positive	Motivation for Continious Learning
85	Post - Wanted to take on new Learning	Motivation for Continious Learning
86	Post -Different Dimensions of Problem Solving	FutureSkills Adopted
87	Post -No benefit going through this process	Motivation for Continious Learning
88	Post- Technique helps create exciting learning environment	Motivation for Continious Learning
89	Practical Versus Theory	Andr-Principle 4: Problem centred
90	Prior Gamification Exposure - Negative	Game-Participation
91	Prior Gamification Exposure - Positive	Game-Participation
92	Prior Robotics Learning Exposure with Gamification - Negative	HRI- Perception of technology changes
93	Prior Robotics Learning Exposure with Gamification - Positive	HRI- Perception of technology changes
94	Redundancy caused by technology	HRI- Perception of technology changes
95	Session - Potential to be seen as Novelty	HRI-Influence Motivational State
96	Session - Self Learning	HRI-Influence Motivational State
97	Simplication changed perception	HRI- Perception of technology changes
98	Simplified Technology	HRI- Perception of technology changes
99	Test - Application of Lessons	Andr-Assumptions HRI- Real world problems using Multi-disciplinary team
100	Test - Applied more than thought	Andr-Assumptions HRI- Real world problems using Multi-disciplinary team
101	Test - Collaboration ensured success	Andr-Assumptions HRI- Real world problems using Multi-disciplinary team
102	Test - Competitive Behaviour	Andr-Assumptions HRI- Real world problems using Multi-disciplinary team

103	Test - Competitive Behaviour - Walked away	Andr-Assumptions HRI- Real world problems using Multi-disciplinary team
104	Test - Not able to apply lessons	Andr-Assumptions Andr-Principle 3: Relevance directly to learners current life as well as impact on their working environment HRI- Real world problems using Multi-disciplinary team
105	Using Robotics to solve BioChem problems	HRI- Perception of technology changes
106	World is Changing - Exposure for some to potential of automation	Andr-Principle 3: Relevance directly to learners current life as well as impact on their working environment
107	World is Changing - Look at work differently	Andr-Principle 3: Relevance directly to learners current life as well as impact on their working environment
108	World is Changing - Negative	Andr-Principle 3: Relevance directly to learners current life as well as impact on their working environment HRI- Perception of technology changes
109	World is Changing - No link to current work environment	Andr-Principle 3: Relevance directly to learners current life as well as impact on their working environment
110	World is Changing - Positive	Andr-Principle 3: Relevance directly to learners current life as well as impact on their working environment
111	World is Changing - Potential	Andr-Principle 3: Relevance directly to learners current life as well as impact on their working environment

Appendix 2: Phase One: Class Survey Questions

No	Question	Scale				
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
		1	2	3	4	5
1	Has this exercise helped expose you to Complex Problem Solving					

		Likert
2	Has this exercise helped expose you to Critical Thinking	
3	Has this exercise helped expose you to Creativity	Likert
4	Has this exercise helped expose you to People Management	Likert
5	Has this exercise helped expose you to Collaboration with Others	Likert
6	Has this exercise helped expose you to Emotional Intelligence	Likert
7	Has this exercise helped expose you to Judgement and Decision Making	Likert
8	Has this exercise helped expose you to Negotiation	Likert
9	Has this exercise helped expose you to Cognitive Flexibility	Likert
10	Has this exercise helped expose you to Fear of Failure	Likert
11	Has this exercise helped expose you to Leading with Influence	Likert
12	Has this exercise helped expose you to Agility and Adaptability	Likert
13	Has this exercise helped expose you to Good Communication	Likert
14	Has this exercise helped expose you	Likert

	to Curiosity and Imagination	

Appendix 3: Phase Two: Interview Questions

Research Question Section 1 – The Event itself

Interview Questions:

Have you done something like this before, using robots in scenarios to teach concepts?

1. Did you find yourself motivated to participate in the exercises? Was there specific things that you thought aided with the motivation?
2. Did you find the session relevant to the way the world is changing?
3. Did you find when you didn't get something right you wanted to keep trying?
4. Did you find you were exposed to Critical Thinking, can you give me examples if so?
5. Did you find you were exposed to Creativity, can you give me examples if so?
6. Did you find you were exposed to complex problem solving, can you give me examples if so?
7. Did you find you were exposed to people management, can you give me examples if so?
8. Did you find you were exposed to collaborating with others, can you give me examples if so?
9. Did you find that the competitive component, the race at the end, enable you to want to apply what you have learnt?

Research Question Section 2 – 6+ Months after the event

Interview Questions:

1. Have you made any decisions differently around those 5 skills over the last 6 months? Do you have any examples?
2. Have you found that you have an interest in wanting to learn something new? If so, do you have an example?
3. Do you believe you have benefited from being through this teaching technique using robotics to transfer skills and if so why?

4. Do would you like to go on training in future that involves Human-Robot Interaction (HRI) as a component of Gamification and if so why?

Appendix 4: Ethical Clearance

Gordon
Institute
of Business
Science
University
of Pretoria

04 July 2018

Bierman Heinrich

Dear Heinrich

Please be advised that your application for Ethical Clearance has been approved.

You are therefore allowed to continue collecting your data.

Please note that approval is granted based on the methodology and research instruments provided in the application. If there is any deviation change or addition to the research method or tools, a supplementary application for approval must be obtained

We wish you everything of the best for the rest of the project.

Kind Regards

GIBS MBA Research Ethical Clearance Committee

Hi Heinrich,

Apologies for the delay in response. I spoke to Jeff and due to us being POPI compliant – especially with the insurance sector that understand the policy so well – I had to run this request by legal.

They have responded to say it will be ok for me to communicate with the group and share the request – it will then be up to the delegates to e-mail Jeff.

As this was a Sector programme there are at least 20 companies represented and therefore no 1 client I can contact for you to gain access to meet these delegates.

Please confirm that it was only the MMDP groups that you require feedback from. I will then send on your mail for context.

Regards

Divania

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