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THE AMERICAN UNIVERSITY IN CAIRO
الجامعة الأمريكية بالقاهرة

**School of Business**

# Impact of Artificial Intelligence on Education for Employment: Learning and Employability Framework

A Thesis Submitted to:

Sustainable Development Program

In partial fulfillment of the requirements for

The degree of Master of Science in Sustainable Development

By:

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Under the supervision of:

Dr. Ayman Ismail (Supervisor)

School of Business, The American University in Cairo

September, 2019

# Abstract

Sustainable development has been a global goal and one of the key enablers to achieve the sustainable development goals is by securing decent jobs. However, decent jobs rely on the quality of education an individual has got, which value the importance of studying new education for employment frameworks that work. With the evolution of artificial intelligence that is influencing every industry and field in the world, there is a need to understand the impact of such technology on the education for employment process. The purpose of this study is to evaluate and assess how AI can foster the education for employment process? And what is the harm that such technology can brings on the social, economical and environmental levels? The study follows a mapping methodology using secondary data to identify and analyze AI powered startups and companies that addressed the learning and employability gaps. The study revealed twelve different AI applications that contribute to 3 main pillars of education for employment; career exploration and choice, skills building, and job hunting. 94% of those applications were innovated by startups. The review of literature and study results showed that AI can bring new level of guidance for individuals to choose their university or career, personalized learning capabilities that adapt to the learner's circumstance, and new whole level of job search and matchmaking.

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## List of Acronyms

| | |
|---|---|
| AGI | Artificial General Intelligence |
| AI | Artificial Intelligence |
| AMTEC | Advance Manufacturing Technical Education Collaborative |
| ANI | Artificial Narrow Intelligence |
| AR | Augmented Reality |
| ASI | Artificial Super Intelligence |
| ATS | Applicant Tracking System |
| BIS | Basic Interest Scales |
| CPA | Certified Public Accountant |
| CRM | Customer Relationship Management System |
| DiSC | Dominance, Influence, Steadiness, & Conscientiousness |
| EFE | Education for Employment |
| FAQ | Frequently Asked Questions |
| GOT | General Occupational Themes |
| GDP | Gross Domestic Product |
| INC | Instant Note Capture |
| IoT | Internet of Things |
| ILO | International Labor Organization |
| ISA | Income Share Agreement |
| ITS | Intelligent Tutoring Systems |
| KLSI | Kolb Learning Style Inventory |
| LMS | Learning Management Systems |
| LNPL | Learn Now, Pay Later |
| MBTI | Myers-Briggs Type Indicator – Assessment |
| MOOCs | Massive Open Online Courses |
| MDGs | Millennium Development Goals |
| NCRC | National Career Readiness Certificate |
| NEET | Not Employed, or in Education or Training |
| NGO | Non-Governmental Organization |
| NLP | Natural Language Processing |

| | |
|---|---|
| O*NET | Occupation Information Network |
| OS | Occupational Scales |
| PMP | Project Management Professional |
| PSS | Personal Styles Scales |
| PWC | Price Water Coopers (Company Name) |
| RIASEC | Realistic, Investigative, Artistic, Social, Enterprising, & Conventional |
| SBT | Simulation Based Training |
| SDGs | Sustainable Development Goals |
| SII | Strong Interest Inventory - Assessment |
| SNARC | Stochastic Neural Analog Reinforcement Calculator) |
| STA | Elsewedy Technical School |
| UN | United Nations |
| UNDP | United Nations Development Program |
| UNICEF | United Nations International Children's Emergency Fund |
| VR | Virtual Reality |
| WHO | World Health Organization |

# CHAPTER 1: INTRODUCTION

## 1.1 Background of the Problem

Artificial intelligence has been a buzz word that is impacting every industry in the world. With the rise of such advanced technology, there will be always a question regarding its impact on our social life, environment and economy thus impacting all efforts exerted towards sustainable development.

First, what is artificial intelligence? Marvin Minsky and John McCarthy described artificial intelligence as any task performed by a program or a machine that, if a human carried out the same activity, he/she had to have intelligence to accomplish the task (Heath, 2018).

So how such intelligence contributes to achieving the world's sustainable development goals? Sustainable development is defined as the development that meets the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987). In September 2015, all 193 Member States of the United Nations adopted a plan for achieving a better future for all — universal call to action for the next 15 years to end extreme poverty, fight inequality and injustice, and protect our planet. This plan Composed of 17 Sustainable Development Goals (SDGs) that demonstrate the alignment for a new universal Agenda (UN Global Compact, 2016).

From the definition, the welfare of human beings is the core of sustainable development. Sustainable development is useful only when ordinary people's lives are improved whether in health, education, employment, environment, equality or justice. Securing decent jobs is a key enabler to promote the components of sustainable development; economic growth, social welfare and environmental sustainability. Decent jobs allow access to living wages, social security, rights and enhance physical and mental health (Sustainable development through decent jobs for youth, n.d.). The Human resources are the precious resource for nations. The high unemployment and underemployment rates especialy in youth, is a great threat affecting the sustainable economic development of countries and is influenced by investment in education, and quality of living (Aceleanu, Serban, & Burghelea, 2015).

Pauline Rose, former director of the Education for All report, stated that the main cause of the high unemployment rates is the poor education systems that fail to equip young people with the

required skills for the labor market (Young, 2014). Additionally, the Global Education Monitoring 2015 report showed that around 781 million individuals are illiterate. This huge numbers who lack the basic literacy skills, will struggle to find decent jobs which will leads to social imbalance and threats in different angles including health, security, children development, and living standards (Global Education Monitoring Report Team, 2015).

So, education and employment are strongly connected. Vladimirovaa & Blanc (2015) believed that SDG 4 (Quality Education) is most connected to SDG 8 (Decent Jobs & Economic Growth) and SDG 5 (Gender Equality). By contrast, SDG 6 (Clean Water), SDG 7 (Clean Energy), SDG 11 (Sustainable cities), SDG 12 (Sustainable Consumption and Production) and SDG 13 (climate change) are the least in linkage with SDG 4 (Quality Education). Having said that, it's clear that education for employment is a core linkage between SDG 4 & 8.

## 1.2 Problem Statement:

There is not enough research on the use cases of AI on the domain "Education for Employment" or in other term "Learning & Employability" that would allow the design of suitable interventions to utilize such disruptive innovation to improve the "Education for Employment" existing frameworks.

## 1.3 Research Gap:

SDG 4 (Quality Education) and SDG 8 (Decent Work) are directly connected in the domain of "Education for Employment". Researches were published on how to improve education curricula to enhance the employability of students; frameworks were designed to facilitate the work of teachers, mentors, career advisers and faculty to guide students through their career exploration and preparation. Papers were published on the impact of AI on education and its impact on employment. But it seems there is a gap in connecting the three fields of research; education for employment, AI in education and AI in employment.

Studies are needed to evaluate and assess how AI can fit in the current learning and employability frameworks and to evaluate what can innovation and entrepreneurship bring to promote better education for employment systems or solutions. .

## 1.4 Research questions:

1. How can AI play a role in fostering the education for employment process?
2. What kind of innovation can startups bring in the learning and employability frameworks using AI technologies?
3. Will AI bring disadvantages to the process? How it may affect the society, the environment and economy while impacting the education for employment process? And how can we avoid its harm?

## 1.5 Objectives:

The aim of this study is to shed light on the ways of utilizing the availing AI technologies in providing vast opportunities that facilitate achieving SDG 4 & SDG 8 while avoiding the harm and disadvantages that could take place in the form of biased learning, increased unemployment or other negative impacts. In order to be able to answer the research questions, the study tackled the following research objectives:

1. Understand the current and potential applications of AI in education
2. Understand the current and potential applications of AI in employment
3. Understand different learning and employability frameworks
4. Analyze and evaluate the potentials of AI to foster such frameworks
5. Explore the current and potential endeavors in adopting AI in education and employment

## 1.6 Study Scope & Limitations:

According to the definition of sustainable development, it is not only concerned with one specific dimension, whether economic, social or environmental, but encompasses all three of them. However, for the scope of this study, it will uncover the current applications and implications of AI on the domain of education for employment from an economic and social angle.

Whereas, because of the limited direct connection between SDG 4 (Quality Education) and most of the environmental SDGs including (Water, Climate Change, Clean Energy, & Life below water), the study will evaluate the environmental effects (if any) that is only caused by using the AI technology itself while being applied on EFE.

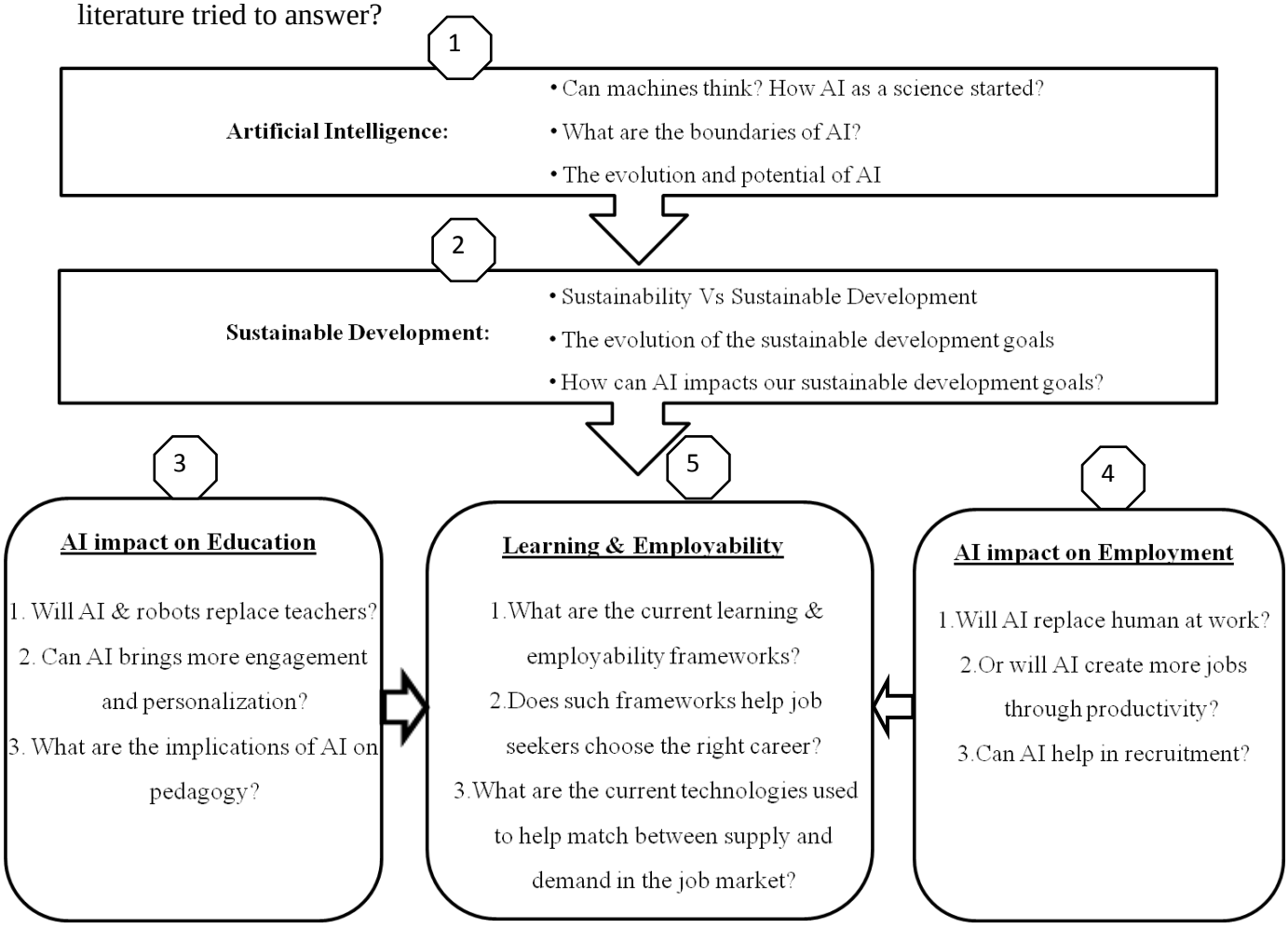
Moreover, the study is assessing new frameworks for learning and employability and how AI can fit in and foster the process, so further experiments should be carried out to ensure the effectiveness of the framework and the accuracy of results of the AI application on the learning and employability process.

# CHAPTER (2): LITERATURE REVIEW

## 2.1 Conceptual Framework

To assess the impact of AI applications on education for employment and how this reflects on achieving the sustainable development goals, one must have a clear understanding of what AI is, its applications, what is sustainability, what are its goals and how technology impacts SDG 4 (Quality education) and SDG 8 (Decent Work), and last but not least, what are the current learning and employability frameworks. At the end, this review concludes with a summary of the previous efforts to assess the impact of AI on education quality and decent work which are two of the sustainable development goals SDGs and how learning and employability frameworks can utilize the best of AI innovations.

In Figure (1) is a diagram illustrating the flow of the literature review and what questions that the literature tried to answer?



## 2.2 The origin of Artificial Intelligence

As an academic discipline, Artificial Intelligence was first set for research at Dartmouth College, USA, in 1956 in a conference held by John McCarthy who was the main organizer and the one who proposed the term "Artificial Intelligence". In the conference, Allen Newell and Herbert Simon introduced the "Logic Theorist" which was the first computer program designed to mimic the problem solving skills of a human being and was considered as the first true artificial intelligence program. The program succeeded to prove mathematical theorems like a talented mathematician (McCorduck, 2004).

Before the term AI was introduced, scientists from different fields (mathematics, psychology, engineering, and political science) started to investigate the possibility of creating a machine that could think or act like humans, in other words, creating an artificial brain. McCorduck (2004) had time lined the history of efforts exerted to mechanize thinking back to the sixth century starting with the written Greek literature about automata. Moving towards the term "Robot" which was introduced into English in a science fiction play by the Czech writer Karel Čapek called (R.U.R.) which stands for Rossum's Universal Robots. McCorduck had captured the historical personal endeavors in the field without covering any technical arguments, methodologies, applications or risks. Away from the historical timeline, Nilsson (2010) described clues that inspired the very first accomplishments in artificial intelligence. He interpreted clues from philosophy, life, and engineering, referring back to Aristotle in philosophy, neurons and brains (which falls under the life clues) then automata and ends by computers in engineering.

McCulloch & Pitts (1943) described that any computable function could be performed by some network of neurons. A net structure can connect those neurons in a way simulating all the logical connectives such as [and, or, not, etc.]. They also proposed that certain networks could learn. What they have described at that time was later known as neural networks which paved the way afterwards to research focused on the application of neural networks to artificial intelligence.

Gurney (2018) clarified, in not too technical terms, what are neural networks and how they are similar to human brains. He illustrated, as shown in figure (2) that human brains consist of billions of "neurons" and that neurons communicate through electrical signals "spikes".

Within the neuron there are electrochemical junctions called “synapses” that mediate the connections. These “synapses” are located at the branches of the neuron cells that are called “dendrites”. Neurons receive multiple signals which reaches the “Cell” which in return integrate the received signals till it reaches certain threshold then the “cell” generates a response as another signal that is also transmitted through an output branch called “axon”.

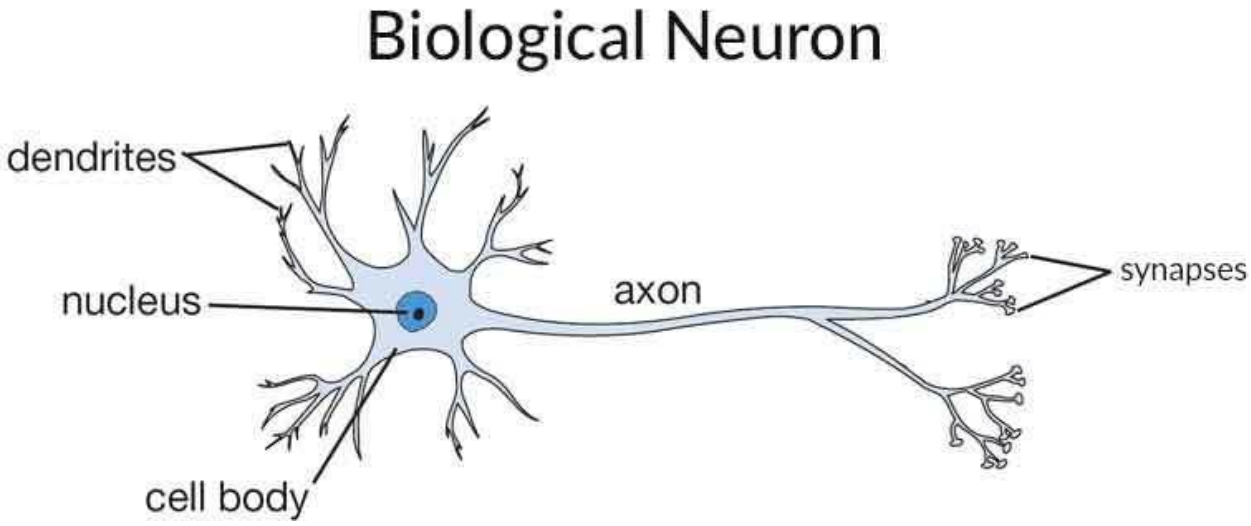



Figure (2): Human Neural Network

The equivalent of the biological neurons is the “nodes” in the artificial neural network. The Synapses are modeled by “Weight”. The integration and summation that is being processed in the cell is simulated by simple arithmetic addition to supply node “activation”. If the “activation” reaches certain threshold, the “node” generates an output.

The idea of neural networks inspired Marvin Minsky and Dean Edmonds, in 1951, to build the first neural net machine that was called the SNARC standing for Stochastic Neural Analog Reinforcement Calculator (Norvig & Russell, 2010).

Turing (1950) questioned: “Can machines think?” and developed the Turing Test that compares the ability of a machine to perform intelligent behavior equivalent to human ones. Turing called this test imitation game where a human is placed in a room and a machine in another one while a second human, who is referred to as the interrogator, is in a third separated room. The interrogator is able to communicate separately using a textual device to each of them

without knowing which response is coming from the machine or from the human. The interrogator role is to differentiate between them based on their responses to his questions. The idea here is, if the interrogator couldn't distinguish the machine from the human, then the machine accordingly is considered to be intelligent. In the test, the interrogator may ask complex arithmetic calculations and the machine should sometimes answer incorrectly to avoid being identified as a quick answer that couldn't be easily answered by a human. Despite the fact that the Turing test was considered a base for evaluating lots of modern AI programs, Luger (1993) saw that the test is vulnerable to be criticized as it referred to human intelligence as a problem solving skill and neglected other components of human intelligence such as the perceptual or emotional skills. The direct comparison between the machine intelligence and human intelligence could be a mistake. Machines intelligence is simply different as it capitalizes on its own assets that are totally different than humans'. Another argument was shared by LaCurts (2011) that if the interrogator asked multiple questions about human experience and the machine answered negatively but intelligently, then the interrogator can identify the machine from the human. So the machine could still be intelligent but yet distinguished from human.

### 2.3 What is Artificial Intelligence?

This is how AI existed, but what is AI all about? Norvig & Russell (2003) classified several definitions of AI through two dimensions. The first dimension addressed the thinking in other words the thought processes and reasoning, while the second dimension addressed the act or the behavior. Definitions can be rearranged as follows:

1. **Thinking Humanly:**
   "Machines who think" (Haugeland, 1985). John Haugeland noted that AI is based on a very simple idea, that human thinking and machine computing are radically the same.

2. **Thinking Rationally:**
   Winston (1992) offered a definition for AI as "The study of the computations that make it possible to perceive, reason, and act".
3. **Acting Humanly:**
   "The art of creating machines that performs functions that require intelligence when performed by people" (Kurzweil, 1990).

4. **Acting Rationally:**

   "Computational Intelligence is the study of the design of intelligent agents." (Poole, Mackworth, & Goebel, 1998). Poole et al. described an agent as something that can do/ act and that an intelligent agent is a system that acts smartly, learns from experiences, adapts and makes choices given limitations and finite computation.

Other scientists saw that in order to define Artificial Intelligence, we should define intelligence as a component first (Luger (1993), Nilsson (1998)). Lugar (1993) saw that the definition of intelligence itself is not well understood. While others believe that there is no single definition or it's tricky to define artificial intelligence (Wang (2008) and Vincent (2016)).

One of the practical definitions for Artificial intelligence describes it as a branch of computer science that focus on automating intelligent behaviors (Lugar 1993). The key here is that it refers to AI as a computer science discipline. Today, modern dictionary definitions follow the same approach in referring to AI as a sub-field of computer science that focuses on how machines can imitate human intelligence. The English Oxford Living Dictionary gives this definition: "The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages" (English Oxford Living Dictionaries, n.d.). While MacMillan Dictionary defines AI as "the use of computer technology to make computers and other machines think and do things in the way that people can" (Mac Millan Dictionary, n.d.).

AI can be classified into three levels; Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI) and Artificial Super Intelligence (ASI) (Strelkova & Pasichnyk, 2017):

1. ANI (Artificial Narrow Intelligence): AI that can do a certain task, and take decisions in a certain field. This doesn't mean that it is a low intelligence but it's narrow in the sense that it can do intelligent tasks, but in a certain defined scope. An AI chess designed program can beat the world's top chess champion in a chess game, but it can't do anything else. Self driving cars still fall under the narrow intelligence (Rouse, 2016).
2. AGI (Artificial General Intelligence): AI that matches or surpasses human intelligence, that might include capabilities such as planning, problem solving, thinking abstractly,

quick learning, and learning from past or previous experiences. There are no AI applications developed till now that posses the ability to take off on its own. (Rouse, 2016).

3. ASI (Artificial Super Intelligence): AI that can be more intelligent than the best human brain in all fields, including creativity, wisdom and social skills.

There are lots of AI technologies that are the base for hundreds of applications developed nowadays. Kumar (2018) summarized the most used technologies of AI into four:

1. **Machine Learning (ML):** The ability of a machine to learn by gaining experience and training. Usually done by providing a training data set and the machine starts to learn similar to how a baby is learning by visually seeing multiple images of an object, for instance, allowing the machine to define the steps to identify the same object again and again but in different images.
2. **Natural Language Processing (NLP):** The ability of recognizing a language (by voice or text) and process it to data. Example: How chatbots understand and reply to conversations.
3. **Vision:** The ability of recognizing objects in images or visuals and process visual information. Example: Facebook recommendations for friends' tagging.
4. **Robotics:** Is mainly an engineering field concerned with designing and manufacturing of robots. The programming part that allows the robot to recognize objects, voice, text and take actions is an AI technology. Example: Robots are now used in factories to assemble parts instead of workers.

With the advancement of the computing powers, new AI technology emerged which is deep learning. Unlike machine learning, there is no human in the training loop. In machine learning, there should be a human that performs feature extraction process and then let the machine identify how to classify and recognize patterns. But in deep learning, the feature extraction step is also done by the machine directly without the need of a human in the training loop.

Usually machine learning is being used when data is structured and can be labeled. But deep learning is used when data end points are huge and unstructured. That said, deep learning needs huge training data sets in order to reach high accuracy in feature extraction and training (Kapoor,

2019). The figure below illustrates the difference between deep learning and machine learning during the feature extraction and training process.

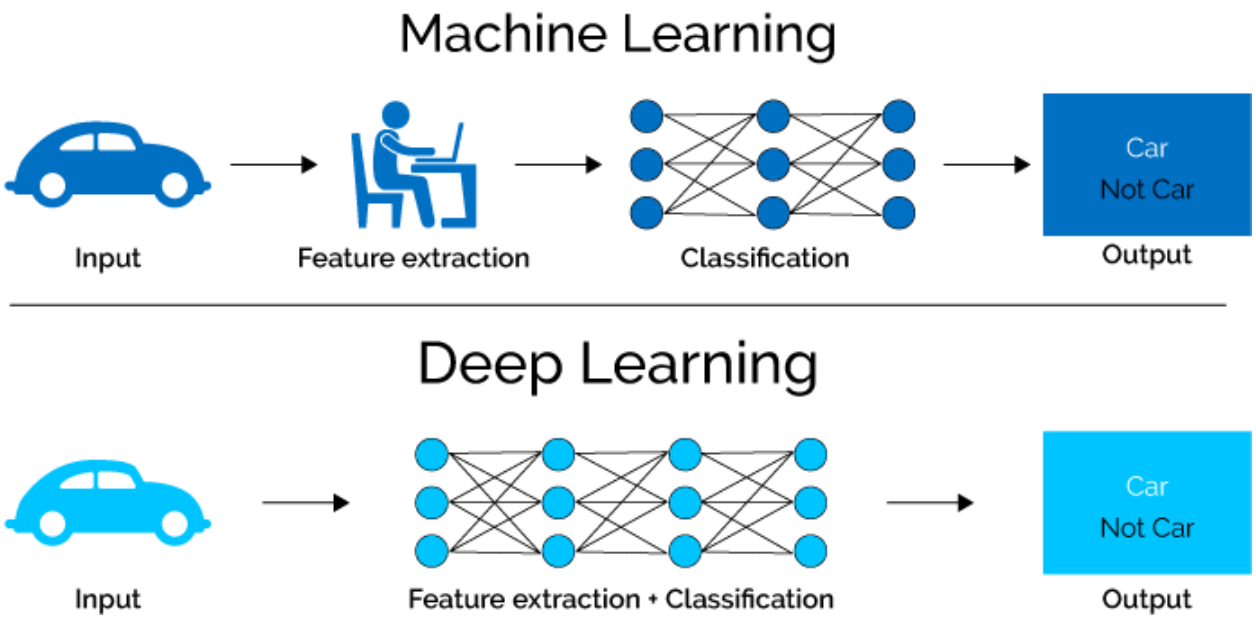



Figure (3): Deep learning Vs machine learning

**2.4 What is sustainability?**

Sustainability can be considered the goal or end in mind of a process called sustainable development (Diesendorf, 1999). The most known definition for sustainable development is the one stated in the United Nations World Commission on Environment and Development released report (Our Common Future); "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (UN World Commission on Environment and Development, 1987).

One of the descriptions of "Sustainability", that has become ubiquitous, is the interconnection between three pillars which are the economy, society and environment. This description proposes the concept of achieving sustainability through balancing economic growth, with social positive impact while maintaining our environment and natural resources safe (Gibson, 2006); Waas, Hugé, Verbruggen, & Wright, 2011); Boyer, Peterson, Arora, & Caldwell, 2016).

In 2000, at the beginning of the new millennium world leaders from 189 countries signed The United Nations Millennium Declaration committing to 8 common language global development goals to be achieved by 2015. Those 8 goals were known as Millennium Development Goals (From MDGs to SDGs, n.d.).

Since the inception of these MDGs, remarkable progress has been made towards achieving the MDGs. According to The Millennium Development Goals Report (2015), the proportion of the population in the developing world who live on less than $1.25 a day in 1990 decreased to 14 per cent in 2015. The literacy rate showed an increase from 83% to 91 % between 1990 and 2015 among young generations aged 15 to 24. Within the same period of time, the global under-five mortality rate has decreased from 90 to 43 deaths per 1,000 live births. In 2015, 91 per cent of the global population is using an improved drinking water source, compared to 76 per cent in 1990. WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation published that in 2010; 89% of the world's population had access to improved drinking water sources while the MDG target was 88% (Progress on Drinking Water and Sanitation, 2012).

However what has been achieved was uneven across countries. Around 800 million people still live in extreme poverty and suffer from hunger. In 2015, one in three people (2.4 billion) still use unimproved sanitation facilities. An estimated 5.2 million hectares of forest were lost in 2010. Millions of people are being left behind (Millennium Development Goals Report, 2015).

In 2012, the key output of the United Nations Conference on Sustainable Development in Rio de Janeiro was a set of universal goals; The Sustainable Development Goals (Background of the sustainable development goal, n.d.). The SDGs will carry on the momentum of the MDGs and set as a global development framework beyond 2015.

### 2.5 Artificial Intelligence from the lens of sustainability

Schwab (2016) stated that like the previous three industrial revolutions, the fourth industrial revolution, the digital revolution, is transforming our lives and reshaping our economic, social, cultural, and human environments. Today entire industries are being disrupted by tech-centric innovators who bring new technologies to the market (Silva, 2018).

Khakurel, Penzenstadler, Porras, Knutas, and Zhang (2018) explored how AI is impacting sustainability through 5 core dimensions - individual, social, economic, technical, and environmental - and found significant positive and negative impacts. On an economic level, AI is now considered an industry on its own and replacement to low-skilled workers is becoming inevitable especially in the manufacturing industry as robots became more feasible. On the technical level, AI technologies will continue to advance at a level where AI may learn and teach coding which may lead to disruption in the Information Technology (IT) industry in terms of job placements. While on an environmental level, same as for the other domains, AI can bring more technological solutions for waste, pollution management and agriculture. Now thanks to robotics that allowed early crops disease detection, reduce water consumption in irrigation and reduce the use of fertilizers and pesticides; however, it also brings power and energy consumption which will have a negative impact. As for the individual level, AI may impact work in a way that will replace certain kinds of jobs and create new ones and affect engagement, social interactions or isolation. And finally, on the social level, AI can take a role in social media management, automating routine activities, and digital storytelling.

AI might bring advanced automation technologies that can grow the world's prosperity, without impacting people's income or purpose (Tegmark, 2017). Carriço (2018) states that despite his fear of the potential of AI to be weaponized, but he believed it may also create and transform jobs, recover the planet damages due to industrialization, help end poverty, and cure complex diseases.

The economic impact of AI is estimated to be between $1.49 trillion and $2.95 trillion over the coming 10 years. AI's economical potential can be benchmarked to broadband internet, mobile phones and robotics, as they increase the speed and accessibility of information allowing for increased productivity across many sectors. Moreover, AI will not only have direct effect on GDP growth from sectors that develop and produce AI technology, but also an indirect effect through the speed and accessibility of information which will increase productivity in existing sectors (Chen et al, 2016).

Environmentally, it has been argued that Technology will be an instrument helping in combating

the negative environmental effects of the developing economies (Erek, Schmidt, Zarnekow, & Kolbe, 2009). On the other side, there is an increased power consumption and production as well as overuse of current resources associated with the increased use of technology in the past couple of years (Elliot & D, 2008). AI may enable advanced technologies that can help in reducing greenhouse gases such as autonomous cars with eco-driving algorithms and also help in transforming weather forecasting and enhance our understanding of climate change through "Climate Informatics' which need high computing power but with the flourish of deep learning networks this has become easier (Herweijer, 2018).

Socially, Delgado (2018) explored different areas that AI can transform our social life. AI already started to disrupt industries like transportation, criminal justice and advertising. In transportation, Tesla has already reached around 300 million miles driven on autopilot and received preorder from Walmart for 15 of Tesla's electric/AI-powered tractor trailers. Uber is currently working on self-driving technology and with the automation of the ride-hailing economy, this will not only boost productivity when commuters stop thinking about driving and commuting through city traffic, but also reduce the cost of transportation. The cost of requesting a self-driving vehicle will be relatively similar to riding a public bus. In criminal justice, the use of fingerprints is being disrupted by the AI facial recognition. AI will be a critical part of the criminal justice ecosystem, enabling investigators and criminal justice professionals to better maintain public safety (Rigano, 2019). While in advertising, AI is disrupting this industry through personalized ads which may also address how emotionally an individual is taking a purchase decision. With the help of machine learning AI technologies, advertisers will be able to collect consumer data, analyze them and generate instant insights transforming big data about consumers needs, attitudes and preferences into valuable consumer insights (Kietzmann, Paschen, & Treen, 2018).

In 2015, some public figures from different backgrounds such as Stephen Hawking, and entrepreneurs like Elon Musk and Bill Gates were expressing concerns about the risks of super intelligence. Gates believes that at first the machines will do a lot of jobs for us without being super intelligent and at that stage it should be positive if we manage it well. However, within a few decades when intelligence becomes strong enough, this will raise lots of concerns

(Eadicicco, 2015). Whereas Elon Musk, he considered artificial intelligence as the biggest existential threat". While Professor Hawkings shared the same concern not about the current primitive forms of artificial intelligence which proved very useful, but regarding the consequences of creating intelligence that can match or surpass humans in a way that AI would advance on its own, and re-design itself at a tremendous rate (Cellan-Jones, 2014).

### 2.6 Artificial Intelligence impact on Education

AI may become a type of metascience, like mathematics; it will be used as a tool to solve problems in many scientific and technical domains (Schank & Slade, 1985).

It was argued that video-connected AI systems can be used in classrooms to monitor student emotions and attention in real time and use such data with data from social media and Internet of things (IoT) platforms to help teachers and students (Tuomi, 2018). However this has raised concerns regarding privacy and freedom of expression which being argued by Daphne Keller, the director of the Stanford Center for Internet and Society, and Securly CEO Vinay Mahadik; that a good balance between privacy and surveillance should be in place, rather than forcing students to reveal their data without any control (Stolzoff, 2018).

Another disruptive AI technology to traditional teaching is Teacherbots. Teacherbots are defined as any machine-based software or hardware that assumes the role traditionally performed by a teacher assistant in organizing information and providing fast answers to a wide set of predictable questions; it can be facilitating, monitoring, assessing, and managing student learning within the online learning space (Popenici & Kerr, 2017). Bayne (2015) explored how the association of teacher-student-code might be pedagogically productive by using teacherbot and that teacher automation does not have to be about rationalism as teacherbot was not intended to replace teachers or solve any productivity issues. Bandura (1971) theory about social learning emphasize on the idea that AI can't replace teachers as people learn through observing others' behavior, attitudes, and outcomes of those behaviors. Professor Ashok Goel argued for the need of teacherbots from another dimension that students drop out of courses for many reasons but one of the most is because they don't receive enough teaching support. That's why he created Jill Watson; a virtual TA or a teacherbot. The teacherbot "Jill" was trained with 40,000 postings with questions and answers and ended the semester answering hundreds of questions with 97 percent

certainty (Maderer, 2016).

One of the advancements that AI will bring in education is differentiation and individualization of intelligent tutoring systems (ITS) which provides personalized electronic tutoring customized to students' learning styles and preferences (Faggella, 2019). Through ITS, curriculum can be organized around students' progress, combined with real-time feedback. Moreover, according to John Baker – The maker of Brightspace Insights a suite of analytical tools for educators - instructors can use ITS tools to predict learners at risk and help them progress before issues appears at the end of a term (Loeffler, 2018).

The current educational systems overwhelm teachers with administrative and mechanical tasks. A favorite benefit of using AI is that educational institutions can streamline work processes such as grading of essays or measuring student responses. Such workload can require valuable time from lecturers and teachers and they would rather spend this time in 1:1 guidance with students or lesson planning (Schmidt, 2017).

However, Popenici and Kerr (2017) explained that AI may bring biases in education as there are currently couple of teaching practice in higher education will be replaced by AI software using complex algorithms designed and developed by programmers who can transmit their own biases or agendas.

### 2.7 Artificial Intelligence impact on employment

Machines and automation have been replacing humans at work gradually ever since the Industrial Revolution. It started in agriculture and handicrafts, then in mass manufacturing and currently in many administrative tasks. But with the technology advancements, smart machines that are powered by artificial intelligence (AI) and robotics, could potentially replace a larger proportion of existing human jobs than before. It is observed that this replacement will on the other hand create new jobs as in the past, but the concern is the percentage of jobs created will be relatively less than the replaced ones (Hawksworth, 2018). Andrews (2018) predicts that 40% of customer-servicing employees and government workers will be assisted by virtual agents powered by AI to help them in decision-making or process-related support. Outsourcing companies that provide services such as call centers or manufacturing may suffer since large corporates with advanced economies and technology, who outsource services to emerging

countries such as India or even Egypt due to cost, will be able to maximize their AI's capabilities hence they will no longer have the need to pay for outsourcing services as overhead costs will be reduced and accordingly they might stop outsourcing of services and build in-house AI tools or robots (Khakurel et al, 2018).

Frey and Osborne (2013) studied the probability of computerization for 702 detailed occupations and estimated that within the next decade or two, around 47% of total US employment is at high risk because of automation. Workers who perform office and administrative support and others who work in the transportation and logistics field as well as production labors are somewhat vulnerable or at risk. Moreover, PWC UK analyzed over 200,000 jobs in 29 countries to explore the impact of automation and estimated that by mid-2030s 30% of jobs in these countries and 44% of workers with low education are at risk of automation (Hawksworth, Berriman, & Goel, 2018). Ford (2013) has emphasized the importance that adoption of AI for routine jobs should be cautiously done to avoid the pressure created on low education labor under the threat of job loss. The article emphasized that direction of AI adoption should be shifted towards creating new innovations through analyzing data and reaching more insights from data analysis to realize competitive advantages and more effective marketing plans rather than replacing human labor.

With such employment concern, many studies refined such concern and the general consensus now is that AI will generate major transformations in the labor market (Tuomi, 2018). According to Gartner, Inc., AI will create 2.3 million jobs in 2020, while eliminating 1.8 million and by 2025 AI related job creation will reach two million net-new jobs (Gartner, 2017). Moreover, according to a new report from the World Economic Forum (WEF); 75 million jobs are estimated to be displaced, while 133 million new roles may emerge due to machines and algorithms (The Future of Jobs, 2018).

Nilsson (1984) argued that technology and machines have been developed not only to perform tasks, but, it should positively impact the quality of produced goods and services at a lower cost. The study has argued that this transition to technology should result in favorable unemployment that will allow human labor to better perform activities they were never able to do in their current heavy duty jobs. Martens & Tolan (2018) highlighted that throughout the previous waves of

replacing humans with machines, it usually ended up by increased labor as well as increase in wages and payouts.

Schank and Slade (1985) believed that it is unlikely that AI will cause a concern-able unemployment. AI programs will probably be utilized for applications where hiring humans would be too expensive or really dangerous. Overtime, AI programs will take over computer tasks allowing humans to dedicate their time to other kinds of tasks including personal services. While Tuomi (2018) supported the idea that if machines replace some jobs, people will move to another similar to what happened when automation invaded the agricultural and industrial jobs, labor moved to services. According to Masayuki (2016), service sector companies are optimistic about big data and enthusiastic about AI and robotics deployment as it will have direct impact on productivity improvement that eventually reflects on economic growth.

On the other hand, it was realized that AI can positively impact employment if it is utilized properly within the business model (Martens & Tolan, 2018). This can be done by complementing human labor without its replacement. Nevertheless, adopting AI within business models can further result in productivity increases. This is applicable to various business sectors and induces better allocation of manpower in areas where labor is needed. From Singh and Finn (2003) point of view, AI use in creating effective recruitment systems is seen as an inevitable opportunity to make best use of. Still this will stay challenging until firms management pay attention to the importance of allocating budgets to finance the required technology for hiring process.

### 2.8 Learning & Employability Frameworks

Aside from the impact of AI in creating new jobs, replacing jobs or even shifting the job and labor market, there are two global employment crises that already exist away from the implications of AI; high levels of youth unemployment and a shortage of talents who possess critical job skills. Mourshed, Farrell, & Barton (2013) argued that if young people graduating from schools and universities, after exerting lots of efforts, cannot secure decent jobs and observe that sense of respect that comes with such degrees, society may witness outbreaks of anger or even violence. There is an information gap in what works and what does not in preparing young people during their school to employment transition. After conducting analysis of more than 100 education-to-employment initiatives from 25 countries, and surveying more

than 8000 young people, employers and educational providers in nine different countries (United Kingdom, United States, Morocco, Turkey, Mexico, Germany, India, Brazil, Saudi Arabia), Mourshed et al (2013) concluded that employers, education providers, and youth have different understanding of the learning and employability problems. The results show that the three parties live in parallel universes. In the below figure, it was shown how there is a clear disconnect and misperception about youth job readiness from the point of view of employers vs youth vs educational institutes.

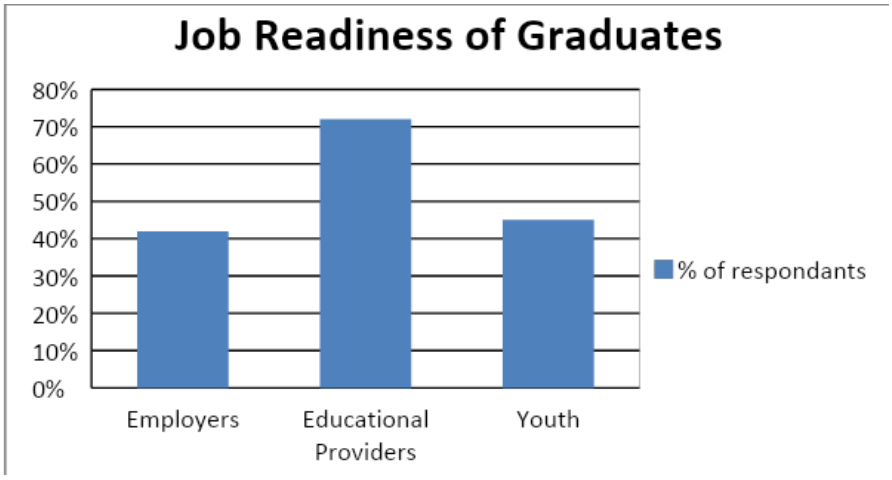



Figure (4): Graduates Job readiness according to Mckinsey analysis in 25 countries

As illustrated in figure (2); more than half of the young people and employers believed that new graduates are not prepared for the job market while, in contrast, educational providers are optimistic that graduates are ready and well equipped to find jobs.

Mourshed et al (2013) viewed the current fragmented education-to-employment system based on their research and survey. They collected and analyzed successful stories across countries with a focus on what went well and how such success could be not the exception but the norm. They represented the system as a highway where the employers, youth and educational providers are drivers heading towards the same destination. Along this highway there are three critical intersections:

(1) Youth getting enrolled in postsecondary education,

(2) Acquiring skills, and

(3) Finding a job

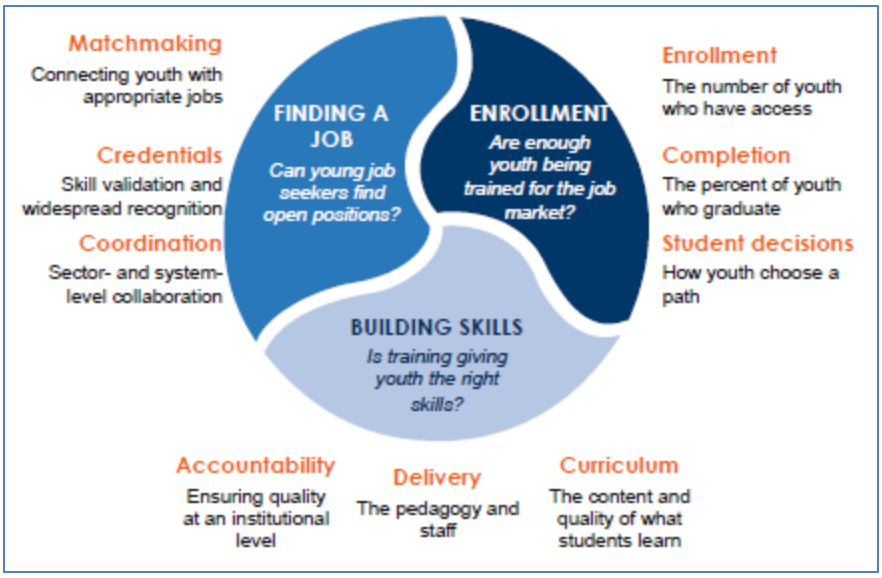



Figure (5): Framework for exploring the education to employment system

One of the surprising findings is that at each intersection, each stakeholder (which was referred to as drivers) view was often so different from one another in a way that it's difficult to believe all those stakeholders are on the same highway. On the other hand, it was found that a key attribute to the success of such framework is the engagement and intensive interaction between education providers and employers. So for instance, employers may help in developing or guiding the educational curriculum and offer their employees and experts to provide lectures or workshops, while providers can develop learning simulations for the workspace environments.

The framework proposed different layers of interventions under each pillar (Enrollment, Skill Building & Job Hunting):

1. **Component One: Enrollment:**
   a. <u>Information Sharing:</u> At this layer there are two steps need to be taken:
      (i) Create comprehensive occupations database and educational/training opportunities

United Kingdom's National Career Service provide information, advice and guidance to help job seekers across England make decisions on learning, training and work. Their website allows users to explore different career options including jobs profile, salaries, industry trends and offer webchats with career advisors beside their skills health check assessment that help users to find out what kind of jobs that best suits his/her skills. Users can also find training opportunities (National Careers Service, n.d.).

In the US, The O*NET (Occupation Information Network) Program is the nation's primary source of occupational information. O*net database includes more than 1100 Occupations. Students and jobseekers can take certain assessment such as John L. Holland's codes or the Holland Occupational Themes (RIASEC) which considered as a leading theory in careers and vocational choice based upon personality types (Rayman, 2008). The Occupational Information Network (O*NET) is developed under the sponsorship of the U.S. Department of Labor/Employment and Training Administration. (National Center for O*NET Development, n.d.).

(ii) Engage the audience and their housing communities

There was a clear issue not only with young people who lack the data about jobs and training but also with the disengaged youth segment who don't really care about searching internet to explore different occupations or career options.

One way of getting them engaged is by embedding career planning and development modules in their academic curriculum in a way that challenges students to rethink about the career after school. In Queen's University, Major maps was designed to help students get academic-major advice, offer suggestions to extra-curriculars activities, networking, international opportunities and career development all in one place and can be used to track accomplishments. The career service center offers drop-in advising, career workshops, and career counselling sessions (Queen's major Maps, n.d.). Another good example was that implemented by the American University in Cairo where a co-curricular transcript was introduced to be the first in Egypt and the Middle East. It's a new fully automated system thatenables the students to record their participation in various activities and development organizations outside of the classroom. The student can access the system online, submit his/her co curricular achievements for verification and after that an official co curricular transcript can be issued from the Office of the Dean of Students. This empowers the students to polish their profile in front of employers, acknowledge their skills and boost their career (AUC Cocurricular Transcript, n.d.).

The second engagement way is through increasing awareness of youth and their parents about various career opportunities and options. Pratham Institute in India started an initiative called Pratham Institute for Literacy, Education and Vocational Training. This initiative succeeded in building large team of mobilizers who interact with local communities, parents and leaders

across different states to reach out to youth, provide information and assist in training and job enrollment. The role of the parents, communities and leaders is to encourage youth to strive for their livelihoods. The initiative provides the engaged youth blended learning solutions that include practical training using simulations for workplace as well as audio-video content to enhance the learning pace (Pratham Institute Approach, n.d.). In 2017, Pratham vocational training initiative impacted 20,000 youth in 18 states with 78% job placement in different industries including construction, healthcare, hospitality, automobile and beauty (Pratham Education Foundation Annual Report, 2017).

b. Dealing with social perception

It seems that a perception is widespread that getting a decent job with good salary requires being a college graduate. So this puts social pressure on youth to go to college and influence others' choice away from the vocational tracks (Mourshed et al, 2013). Brunello and Rocco (2017) argued that youth who graduated from vocational education have a higher likelihood of being not employed and with no education or training within the past 12 months (NEET). They also found that vocational education is associated with poorer labour market returns. This as a result impacted on the perception about vocational education.

Frinault (2018) believed that employers need to attract Millennial and Gen Z to the blue collar jobs by removing the stigma associated with work as a manual labor. HR professionals need to work on shifting mindsets of youth towards working as a blue collar as this what they want and prefer not because they don't have other opportunities. In Germany, companies started to partner with vocational schools and offer apprenticeship programs to remove the stereotypes. Mourshed et al (2013) conducted interviews m with facilities training manager, key account manager, and facilities human-resources manager in Siemens to find out what practice they did in Siemens to attract talented youth to work in their cutting-edge gas-turbine facility in North Carolina. The German company Invited high-school students plant visit along with their parents who were initially resisting the idea of working in a factory. The output of such visits was changing the perception of the parents and youth. One of Siemens' managers was quoted during the interview; "You see robots and lasers and computers and realize it is advanced, modern-day manufacturing, which completely changes perceptions".

c. Dealing with education affordability

Schultz (1961) and Becker (1962) introduced individual choice model of human capital investment in which they presented individual's education choice as an investment decision. Individuals sacrifice economically in order to acquire knowledge, referred to as 'human capital', that will enable them to get better rewards in the future. As illustrated in figure (4), areas 1 and 2 is the duration when individuals are engaged in full-time study. During this period, the individual doesn't have a source of income while paying tuition and other costs of study including accommodation, transportation, etc. Area 3 represents the period after graduation when individuals start to expect benefits from getting enrolled in education for employment and it shows the difference between the expected incomes with and without education. If young people have no access to credit or savings, this may limit their choices and they will not be able to enrol in study.

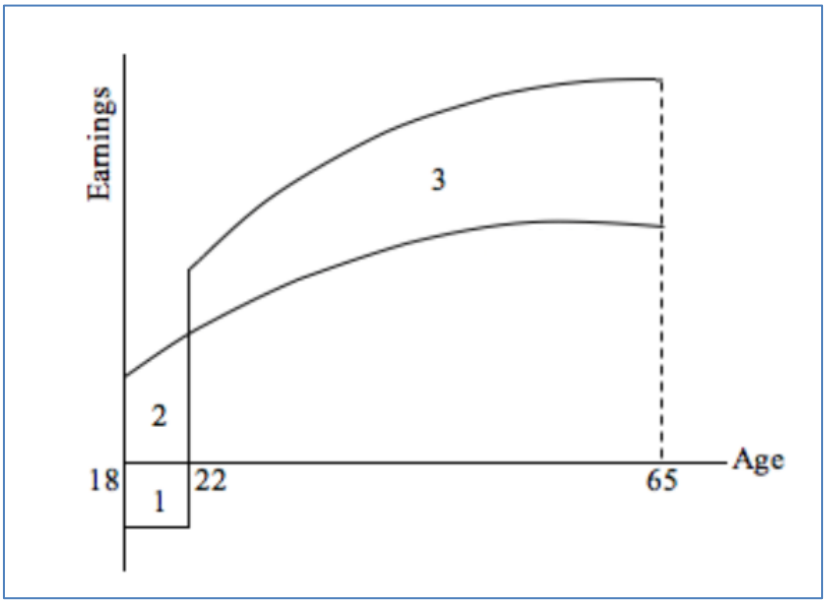



Figure (6): Shultz-Becker human capital model

In order to ease such dilemma on students and to facilitate their engagement and enrollment, Mourshed et al (2013) explored different successful interventions being implemented in different countries:

1. Traditional Scholarships and Subsidies
2. Employers get involved in financing education for employment tracks

3. Educational providers use online technologies to reduce the expansion costs
4. Hire less experienced teachers, trainers and instructors and enable them with capacity building programs and on job trainings
5. "Learn now, pay later" financial model

This "Learn now, pay later" financial model is one of the innovative models that enable deserving students with low financial capabilities to have access to educational services. This model was implemented by Pratham in India. Pratham team categorize students according to financial and family backgrounds and deserving students can pay the course fees in installments, enabling them to get trained and pay after getting a job and generating income. Over 1500 underprivileged students enrolled and benefited from the LNPL financial model (Pratham Unique Model, n.d.). Such model is based on Income Share Agreement, which is basically allowing students to finance their education and pay after graduation based on a percentage of their income (A new, outcomes-based solution is needed to finance higher education, n.d.).

Ross (2019) explored different successful income sharing agreement cases. One of which was Lambda School, an online learning start-up founded in 2017 focused on subjects like coding and data science and is expanding into a multidisciplinary school with 6 months programs teaching professions with significant hiring demand such as cybersecurity. Students pay only 17% of their after graduation salary for 24 months and this is conditioned on making salary more than $50k per year. Not only startups adopted such a model, but also universities. Purdue University introduced "Back a Boiler" program which is considered the first four-year institution to offer such an option. Graduates pay their tuition fees over 10 years after graduation when they find a decent job. And if they did not get a job, they do not pay anything. The payments are according to their income, so the less they generate income, the less they pay (Cohn, 2019).

**2. Component Two: Skill Building:**

This pillar is crucial because it represents the outcome of the previous pillar. So Youth who got enrolled, should come out with certain acquired skills that employers are looking for. This requires two main interventions:

a. <u>Effective content and curriculum design:</u>

ii) Mourshed et al (2013) proposed that in order to design relevant curriculum to the employers' requirements, close engagement between, industry leaders and educational providers is needed. Such engagement to succeed, intensive collaboration should exist while defining the core requirements on a very detailed level to ensure that the aspired learning outcomes will be achieved. (Gottlieb & Backlund, 2015) shed the light on AMTEC as one of the inspiring examples that succeeded in designing a nationwide standard curriculum through strong partnerships at large scale. With the help of the National Science Foundation in United States, and in collaboration between community colleges and automotive manufacturers, AMTEC (The Advanced Manufacturing Technical Education Collaborative) created a standardized curriculum that is based on the industrial skills and competence needed by the industry. The initial partnership started with Kentucky Community and Technical College System and Toyota. Now AMTEC operates in 12 different states with 30 community colleges and 34 industry leaders including Toyota, BMW, Ford and GM. The curriculum is designed in a very detailed specific level, yet easy to follow, with the participation of technicians from different automotive companies. The idea was to capture instructions of how to perform technical tasks and the skill set that is needed to perform it. The curriculum now comprise of 12 courses and 62 modules. The outcomes of such an initiative was outstanding at all levels; students who get enrolled are trained on customized content connected to job requirements, community and technical colleges possess a detailed advanced curriculum recognized by industry leaders, and employers can easily find highly skilled labor that match their technical hiring requirements. The world Economic Forum reported on the success of AMTEC initiative; around +20,000 are impacted annually and AMTEC start to develop virtual technologies to spread their curriculum and methodology on a regional and global scale. However the challenge in scaling within other industries may face some difficulties such as technology availability and access. The presence of technical labs, that include welding equipment, machinery and pneumatics, which enable experienced trainers to provide proper instructions (McKinsey & Company, 2014).

The below figure shows the average pre and post training assessment scores and how such detailed curriculum design and intensive employer engagement can transform the learning outcomes.

Student Performance Using AMTEC Modules

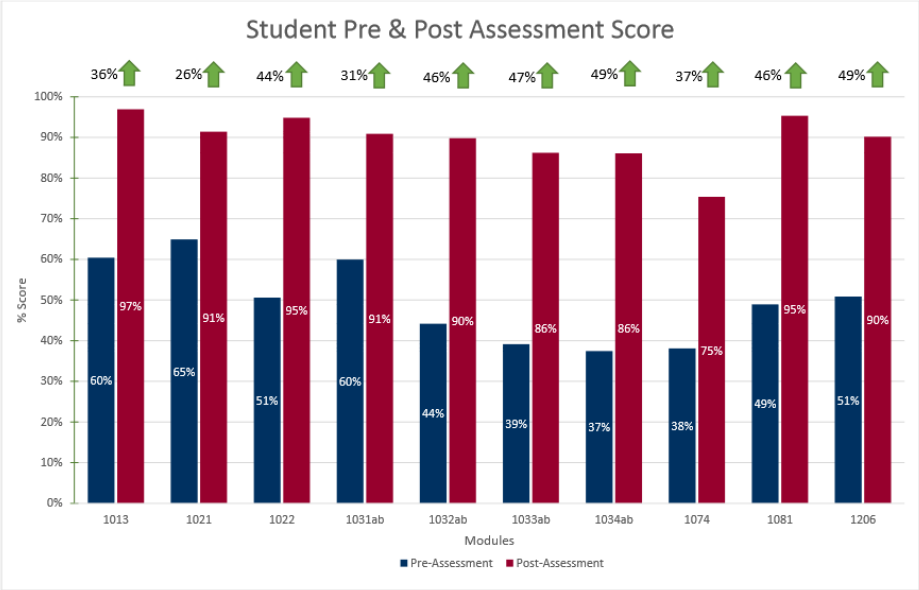



Figure (7): AMTEC - Average Pre and Post Assessment Scores

iii) Gutierrez (2018) referred to microlearning is the latest buzzword in the elearning and instructional design field. Microlearning is simply a new educational approach that is based on designing small learning bites to ease the learning digestion and achieve learning objectives in an efficient and engaging way. Usually such learning bites last 3-7 minutes. Ozdamli, Kocakoyun, Sahin, & Akdag (2016) conducted a research on 140 students from Near East University, Physical Education and Sports Departments, showing that flashcards and infographics as tools of microlearning are effective and memorable than traditional learning methods. Other research showed that students' learning abilities improved by 18% while getting engaged in a microlearning process compared to the traditional way in addition to the overall excitement and motivation of the students was notable (Mohammed, Wakil, & Nawroly, 2018).

With the evidence of how microlearning is useful, macrolearning is inevitable, (Shank, 2018) believed that macrolearning is important to build complex foundational knowledge and that deep learning is built over time. Microlearning should be part of the learning process not the whole process.

b. <u>Effective delivery methods</u>

Effective delivery requires still close engagement between employers and educational providers. Mourshed et al (2013) explored two main ways to do so:

1. Classrooms within workplaces

The common model to bring vocational and technical training within the workplaces is through internships or apprenticeships. In Egypt, a successful initiative was led by Elsewedy Electric in partnership with the Ministry of Education to start Elsewedy Technical School STA. It's a three-year technical secondary school that offers vocational education based on the "dual approach" that combine learning tracks in the school and vocational training tracks in the factory. STA methodology includes blended learning technologies that combine both face-to-face learning and virtual learning environment, which reflects the courses structure. STA training programmes now cover energy Components such cables & transformers, Industrial Electronics, logistics, steel production and others (The initiative: El Sewedy Technical Academy, n.d.).

Loveder (2017) questioned the impact of the 4th industrial revolution on the future of apprenticeships systems. Digital literacy for even low skilled occupations is inevitable and digital skills are required within the modern and future workplaces that are becoming highly mechanised and digitised. This, accordingly, endorses the importance of reforming the training delievry ways in which trainers, students and employers are engaged in.

2. Workplaces within classrooms

Internships and apprenticeships are types of hands-on learning experiences that are most admired by students, however the number of opportunities are limited to accommodate certain capacities of students (Mourshed et al, 2013). However, Bilotta, Werner, Bergese, & Rosa (2013) argued that Simulation Based Training (SBT) has better learning outcomes than traditional educational solutions and apprenticeship models in terms of the students' learning pace, amount of information retained, and practice, especially in clinical practice. A good example of such SBT in the clinical practice is the Nursing Skills Centre of Excellence – Simulation Centre initiated by Box Hill Institute in Australia. During the workshops, that take place in the simulation facility, 2 dedicated staff (Instructor and Facilitator) and 2 other persons who acts as the doctor, or nurse or a distractor are all engaged in close contact with the students using a blended learning approach; face to face teaching and tutorials, e-learning, and skills development laboratories (Nursing Skills Centre of Excellence, n.d.).

The challenge in building such facilities is the high cost, so computer based simulations and augmented reality solutions can be a good scalable alternative. Hamza-Lup (2018) presented

medical training prototype designed to train medical practitioners allowing them to practice without touching a real patient and receive virtual feedback on the results of the practice. The beauty of such AR technology is that it empowers instructors to train local and remote students at the same time and on the other hand, students can observe and witness the internal anatomy of a human patient simulator and accordingly get better understanding of their actions.

Another alternative is "Serious Games" which are games designed not mainly for entertainment but for a primary purpose that is more serious such as training and development (Susi, Johannesson, & Backlund, 2007). Vuksic & Bach (2012) proposed to embed serious games in the business process management education allowing students to build their skills through couple of advanced features in the simulation games such as experimentation, learning by mistakes and deep learning. IBM INNOV8 simulation game was an example of such serious educational games. Students from thousands of universities globally gained free of charge access to INNOV8 so as to gain business and information technology (IT) skills.

3. Elearning & Massive Open Online Courses (MOOCs)

Distance learning, web based training or elearning emerged as a replacement or another approach of traditional classroom training. MOOCs are the evolution of elearning. MOOCs are online courses accessible for masses for free or for affordable comparable price. Usual students who are enrolled in such courses are auto-graded through quizzes or through peer reviews with certain rubric but mostly not instructor based reviews (Bowden, 2019).
(Robson, 2018) argued that MOOCs are a world class education that can be an option for students who can't afford the cost of higher education. With the rising statistics of students loan debt to reach $1.5 Trillion in 2018 as the second highest consumer debt, students are forced either to invest huge amount or not getting a degree (Friedman, 2018).

Khalil & Ebner (2014) investigated on the reasons behind the high attrition rate among students in completing their online studying and founded out several factors including lack of time, being isolated or lack of interaction and hidden costs. Justin Reich and Ruipérez

Valiente - director and a postdoctoral associate, in MIT's Teaching Systems Lab – stated that only 3.3 % of students enrolled in MOOCs completed their courses which reveal how MOOCs providers fail to disrupt the education system (Lederman, 2019).

Such debate regarding the effectiveness of elearning was elaborated by Dr. Will Thalheimer, Learning Expert, who mentioned in an interview that elearning or classroom training is not a "thing" in their own. If both are applied following learning science recommendations such as spacing, and feedback at the right time and way, that would get better results (Dalto, 2018).

### 3. Component Three: Job Hunting:

Finding a job is a painful process for job seekers. According to Mourshed et al (2013) survey only 27% of youth who were interviewed landed a job after more than six months and 55% from those who worked after graduation found jobs relevant to their educational background. Job seekers strive to market their skills, but can't find a credible way to prove their talents, and Employers can't trust the educational degree as a main reference validating youth skills and knowledge. So both employers and candidates suffer in the hiring and talent acquisition process.

Below are examples of interventions that can be done to facilitate this hunting process from both sides:

1. <u>Assessment for qualifications and certifications:</u>

One of the well known processes to show one's credentials and prove his skills and knowledge in a credible way is the international professional certifications such as PMP (Project Management Professional) or CPA (Certified Public Accountant) which could be obtained by Individuals after passing standardized tests (Mourshed et al, 2013). According to Powers (2018) point of view, certifications enable learners to acquire the workforce-readiness skills that employers are looking for. Employers value proactive candidates who strive to develop their skills, gain more knowledge and keep up to date within their areas of expertise. Such international certifications received global recognition over the years and employers in some cases pay higher salaries for certificate holders. According to PMI 2018 survey, PMP holders receive around 23% higher salaries than others (Shenoy, 2019).

However, such certifications mostly require practical experience in order to be eligible to get certified. For instance, PMP certification requires university graduates to have experience equivalent to 4,500 hours of leading and managing projects (Project Management Professional, n.d.). This kind of practical experience is a challenge for fresh graduates and for younger generations, so another way of validation and assessment is needed.

One of the successful alternatives for young candidates in United States is the National Career Readiness Certificate (NCRC) issued by ACT earned through completing different WorkKeys Assessments. Candidates who obtained the NCRC can allow employers to verify their certificates and credentials online, so it acts as a portable credential. WorkKeys assessments focus on verifying individuals' cognitive skills such as their problem solving skills, critical thinking, reading and business writing, applying mathematical reasoning to work-related problems and ability to compare and analyze graphic based information. In order to understand what employers are looking for in order to assess it properly, ACT has scanned more than 20,000 jobs across the states to define the skillset required and the skill level needed to perform successfully in the job. (The National Career Readiness Certificate, n.d.).

Another innovative solution for the assessment and credentials that crossed countries boundaries is the digital badges which introduce much entertainment for online educational activities and experiences. Digital badges are usually used with points and leaderboards which inspire learners to compete with themselves or others (Gibson, Ostashewski, Flintoff, Grant, & Knight, 2013).

2. Matchmaking:

Based on their survey that covered more than 100 initiatives in 25 countries, Mourshed et al (2013) observed that there are many cases that educational providers have built strong relationships with employers so that they can hire their graduates immediately after graduation based on the matchmaking and recommendation process that is being done by the educational providers themselves.

Reaney (2015) argued that with current technological advancement, matchmaking could be a game changer in the employment scene. Websites like Monster.com, CareerBuilder.com,

Indeed.com and LinkedIn.com are among the largest employment websites that exist trying to simplify, streamline, track and speed up the matchmaking process. Flanagan (2014) also agreed that Tinder-style matchmaking is beneficial in the job market as well and shed the light on a similar app called "Emjoyment" which allow job seekers to swipe job posts which includes major highlights about the company, location and only one sentence job description and once the job seeker find a good post, he just hits "like". On the other side, employers start to see job seekers who liked their opportunity in a form of cards including CV main highlights and if the recruiter found an interesting profile, he also hits "like" and at that moment both parties connect together at a push of a button. This kind of matchmaking innovations could decrease the time lost in job applications and finding a good candidate and create direct engagement between employers and job seekers.

### 2.9 Self Awareness models and Career choice

Mckinsey framework, for exploring the education to employment system, started by enrollment and specifically getting access to occupations database or information. There were successful examples for information sharing to youth such as the UK National Career Service and O*Net. However in both examples, there was always a tool to guide students in making their initial choice, either through career advisor (in the UK National Career Service case) or through RIASEC assessment (in the O*Net case). This is done because getting access to information about the labor market and the different career options and occupations is not enough to make career decision and accordingly choosing the right education for employment track to get enrolled in. Getting enrolled in education for employment and pursuing a job is part of the individual's career development. And career development by definition is a "continuous lifelong process of developmental experiences that focuses on seeking, obtaining and processing information about self, occupational and educational alternatives, life styles and role options" (Hansen, 1976). From the definition, it entails that career development is the process of self understanding and matching with occupational options, education and role in life.

In 2006, Andersen (2006) introduced the career diamond model which is a visual tool shows the internal experience that individuals should pass by while pursuing a career. The tool examine individual's self awareness and understanding within the context of the world of work's demand dynamics.

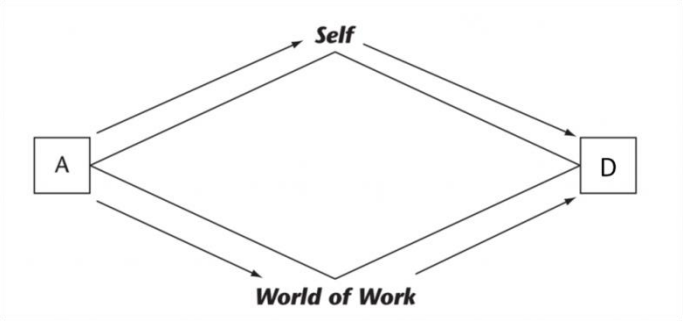



Figure (8): Career Diamond Model

In the figure above, the letter (A) stands for "Awareness" while letter (D) stands for "Deciding". So the process starts as each individual becomes aware of his need to take a career choice or to make a change and ends by the decision for this particular career movement. The diamond includes two phases; phase one is the exploration and expansion phase (<) that includes self exploration and expansion of knowledge and information about the labor market. The second phase is the decision phase, represented by a contracting symbol (>), where individuals start to set their priorities, eliminate different options and make decisions based on what meets the market demand. As career development is a lifelong process, the exploring to convergence process recurs with each major career change or decision, creating a career chain (<><><>).

As self awareness plays a crucial role in individual's career choice, there are several models and assessments that can help young people in exploring themselves. Moreover, self awareness is also important in terms of the preferred learning style of each individual who will enrol in an education or training to acquire the job qualification. Below are some self awareness models:

- **MBTI (Myers-Briggs Type Indicator) Personality Indicators: (Personality)**

  MBTI assessment was founded and published in 1962 by Katharine Cook Briggs and her daughter Isabel Briggs Myers based on Carl Jung's theory of psychological types (Gardner & Martinko, 1996). The test is made up of four pairs of opposite personality attributes which compose a combination of 16 personality types in total (MBTI Basics, n.d.). It measures whether an individual is extroverted or introverted, whether he or she process information based on sensing preference or intuitive preference, whether an individual makes decisions by thinking or feeling and finally whether he or she has a judging or perceiving preference while approaching the outside world. Table (1) shows the 4 different pairs:

| The Four Myers-Briggs Preference Pairs | | |
|---|---|---|
| Extrovert (E) | ⟺ | Introvert (I) |
| Sensors (S) | ⟺ | Intuitives (N) |
| Thinkers (T) | ⟺ | Feelers (F) |
| Judgers (J) | ⟺ | Perceivers (P) |

Table (1): MBTI Four Preference Pairs

As each individual takes the test, he or she decides his/her own preference in each opposite pair and accordingly individuals get their own personality type which is represented by a four letter code. Table (2) shows the 16 MBTI personality types.

| The 16 MBTI Types | | | |
|---|---|---|---|
| ISTJ | ISFJ | INFJ | INTJ |
| ISTP | ISFP | INFP | INTP |
| ESTP | ESFP | ENFP | ENTP |
| ESTJ | ESFJ | ENFJ | ENTJ |

Table (2): MBTI 16 Personality Types

Today, MBTI assessment is widely used in corporates and global organizations, including 89 of Fortune 100 companies and around 2 million people a year (Essig, 2014).

- **DiSC Profile: (<u>Behavior</u>)**

DiSC is one of the leading personality assessment tools. It has been used by over 1 million people every year to enhance productivity, teamwork and communication. It was first introduced by William Marston who holds a Ph.D. from Harvard in physiology and psychology (History of DiSC, n.d.). Marston (1928) explained that the behavioral expression of normal human emotions could be categorized into four primary types; Dominance (D), Inducement (I), Submission (S), and Compliance (C), So DiSC measures patterns of behavior but it does not measure every personality dimension.

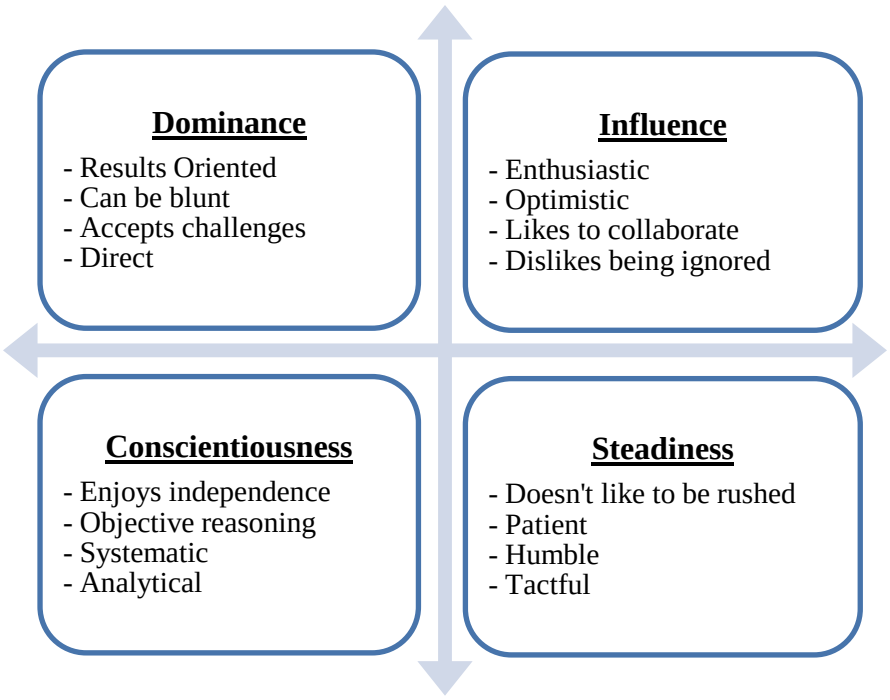



Figure (9): DiSC Profile Model

- **RIASEC or Holland Codes: (Career Interests)**

Holland codes is a well known personality assessment based on a theory of careers and vocational choice that was initially published in 1959 by John L. Holland (Psychologist and Professor in Sociology at Johns Hopkins University) in an article entitled, "A Theory of Vocational Choice," (Nauta, 2010). Holland's idea classifies people according to six personality types: Realistic, Investigative, Artistic, Social, Enterprising, and Conventional (commonly abbreviated with the acronym RIASEC). This assessment is used by O*Net in the "Interests" section to match the individual interests with the occupations available on their database which includes occupational definitions and related skill matrix to help students and job seekers to understand the world of work in the United States. Most people's interests are reflected by two or three Themes and in practice career development professionals uses the top scored 3 themes that resulted from individual assessments and search with this combination of 3 letters on O*Net to narrow the career options that match the individuals' interest (National Center for O*NET Development, n.d.).

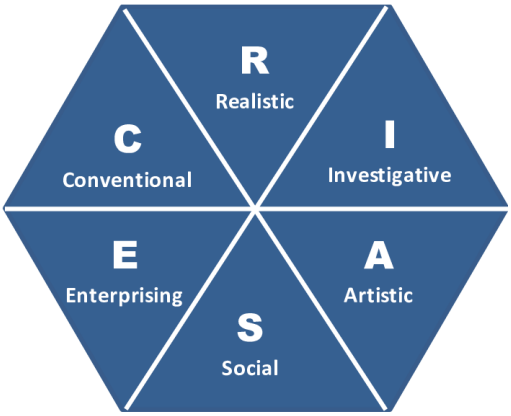



Figure (10): RIASEC Model for Occupational Interests

- **Strong Interest Inventory: (<u>Interests</u>)**

Strong Interest Inventory is another self assessment tool that helps individuals learn more about their interests and accordingly helps them choose their career direction or even college major. In 1927, Edward Kellog Strong (Professor of Applied Psychology at Stanford University) published a self assessment tool he called it the Strong Vocational Interest and then it was known as Strong Interests Inventory (Mckay, 2018). The results of such assessment are represented by a report that includes six main sections:

1. General Occupational Themes (GOT):

   Themes are classified into six areas based on Holland's Codes (RIASEC). But the scores are compared to the average scores based on gender.

| YOUR HIGHEST THEMES | YOUR THEME CODE |
|---|---|
| Social, Artistic, Realistic | SAR |

Figure (11): Sample of GOT results in the profile summary of SII Report.

2. Basic Interest Scales (BIS)

   This scale represents the top interests based on leisure activities, projects, and coursework. Also the interest levels are compared against the average score of the same gender.

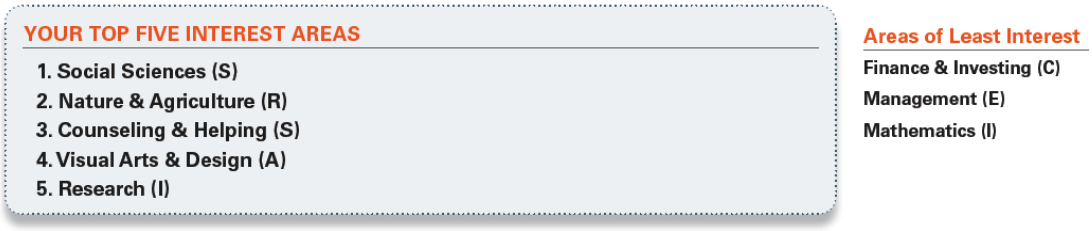



Figure (12): Sample of BIS results in the profile summary of SII Report

3. Occupational Scales (OS)

This scale shows the top 10 occupations that are most aligned with the individuals' interest. The score shows how similar individuals interests are to those who have been working in that occupations and reported satisfied within the same gender. The higher the score, the more results similarity of an individual compared to others.


Figure (13): Sample of OS results in the profile summary of SII Report

4. Personal Styles Scales (PSS)

This Scale represents the personal preferences with respect to work style, learning environment, leadership style, risk-taking and team orientation. Such self understanding can help individuals to narrow down their career options based on such results. The scale is generated by comparing the individual's score with combined group of working men and women.

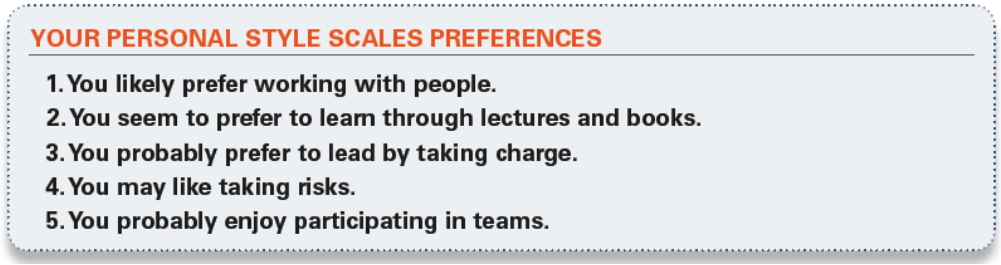



Figure (14): Sample of PSS results in the profile summary of SII Report

5. Profile Summary

   This summary is basically a graphic representation of all the previous results.

6. Response Summary

   This section provides a summary of all responses to the different sections of the inventory.

| ITEM RESPONSE PERCENTAGES | | | | | |
|---|---|---|---|---|---|
| **Section Title** | **Strongly Like** | **Like** | **Indifferent** | **Dislike** | **Strongly Dislike** |
| Occupations | 25 | 31 | 16 | 26 | 2 |
| Subject Areas | 30 | 48 | 20 | 2 | 0 |
| Activities | 39 | 35 | 15 | 9 | 1 |
| Leisure Activities | 32 | 39 | 21 | 7 | 0 |
| People | 6 | 81 | 13 | 0 | 0 |
| Your Characteristics | 11 | 44 | 44 | 0 | 0 |
| **TOTAL PERCENTAGE** | 29 | 39 | 18 | 13 | 1 |

Figure (15): Sample of the Response Summary in the profile summary of SII Report

- **Gallup Strength Finder 2.0: (<u>Strengths</u>)**

  In 2001, Marcus Buckingham and Donald O. Clifton (who was the chairman of Gallup Inc) published a book entitled "Now, Discover Your Strengths". Within the book there was an online personal assessment "Strengths Finder" which afterwards changed to "Clifton StrengthsFinder" in honor of its chief designer. In 2007, Gallup team released a new version of the assessment under named "StrengthsFinder 2.0" (Clifton StrengthsFinder Resource Guide, n.d.). Since the inception of this assessment, Over 20 million people have taken Clifton StrengthsFinder and now used by 1.6 million employees every year and recognized by 467 companies out of Fortune 500 (Chamorro-Premuzic, 2016).

  Clifton StrenghtFinder assesses talents in 34 themes. The concept behind the 34 talents theme is that talents are naturally built in individuals but strength is actually the product or the result of sharpening those talents. Each talent theme is sorted under one of four domains; strategic thinking, executing, influencing, and relationship building. The assessment is composed of 177 paired statements and individuals choose between each two statements the one that best describes themselves (Clifton Strengths, n.d.).

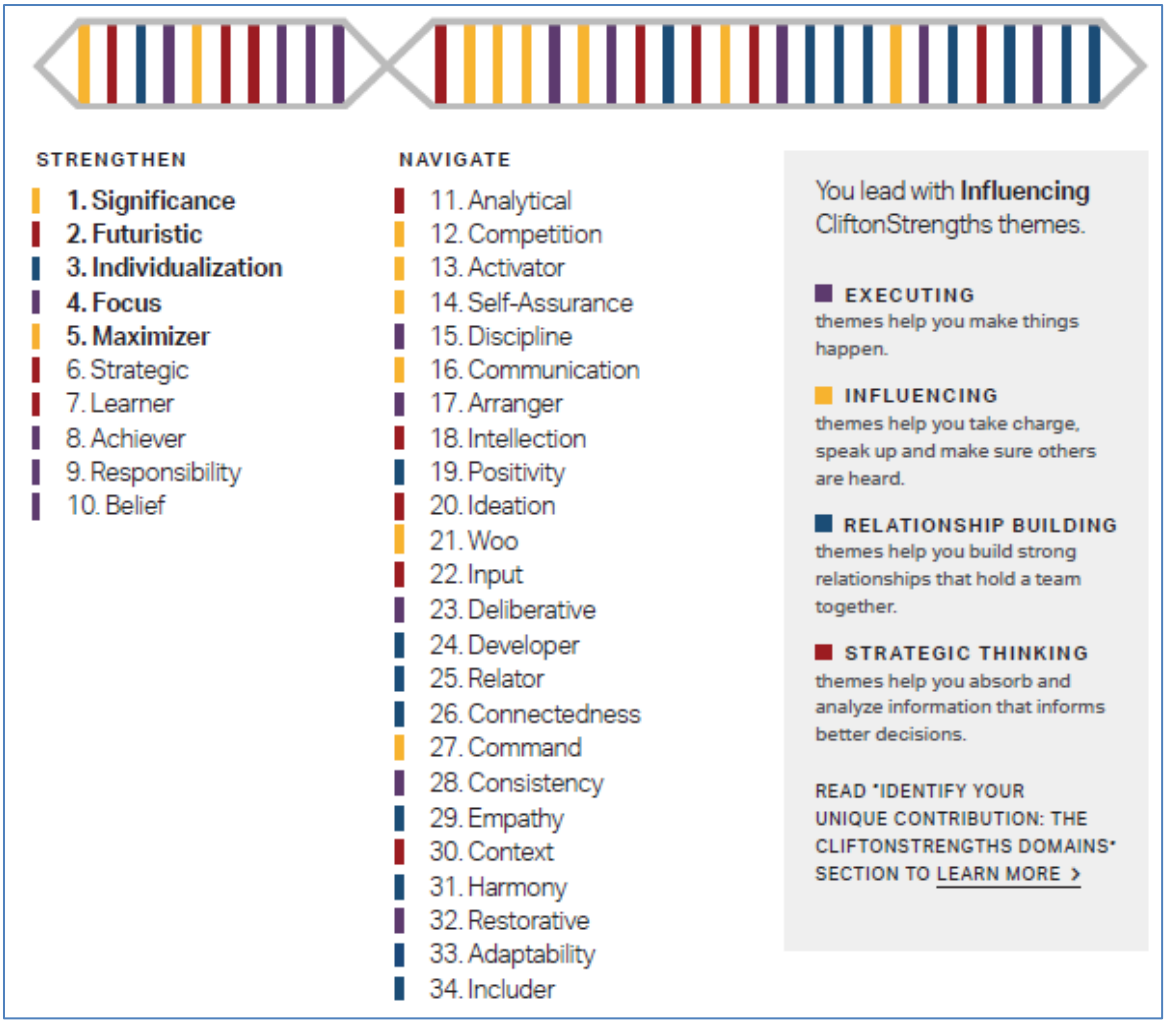



Figure (16): Sample of Gallup – CifltonStrengths Report

- **Knowdell Career Values Card Sort: (Values)**

  Knowdell cards, which is named after Richard Knowdell the President of Career Research & Testing Inc., is a simple tool to help job seekers and career shifters find their own values, prioritize them and match them with their career options that they are exploring. The cards includes 54 listing of values and their brief description. Each individual prioritize those cards under five columns; : Always Values, Often Valued, Sometimes Valued, Seldom Valued and Never Valued (Knowdell, 1977).

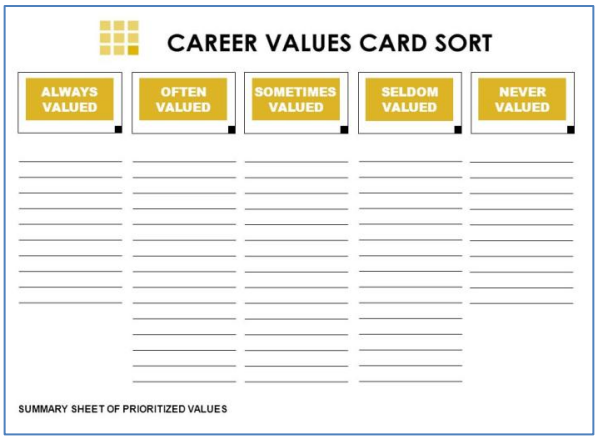



Figure (17): Summary Sheet – Knowdell Career Values Card Sort

Afterwards, each individual uses the career option worksheet to write down one or more career options then weigh each prioritized values against each career option. At the end, high total score entails that one's values support this career option and a low total entails that this career options is not supported by the individual's values.

- **Kolb Learning Styles Model: (Learning Styles)**

  David Kolb classifies the learning cycle into four stages; experience (feeling), reflection (watching), conceptualization (thinking) and testing/experimentation (doing). According to Kolb's theory, learning is an integrated process and each stage supports and feeds the next stage and that learners can start the cycle at any stage and then just follow the logical sequence (McLeod, 2017).

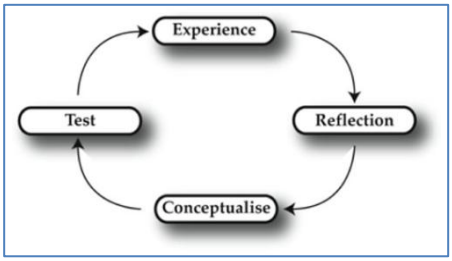



Figure (18): Learning Stages & Sequence

Within those stages, Kolb described four learning styles; convergence, divergence, assimilation and accommodation. Individual's learning style preference is actually a combination of two pairs of variables.

| | Experimentation (Doing) | Reflection (Watching) |
|---|---|---|
| Experience(Feeling) | Accommodation | Divergence |
| Conceptualization (Thinking) | Convergence | Assimilation |

Table (3): Kolb's Learning Styles Matrix

In 2011, Kolb Learning Style Inventory version 4.0 was revised and released which included nine learning style from a 4 to 9 that assess learning flexibility as well and how individuals can adapt to different learning situations (Kolb, 2013).

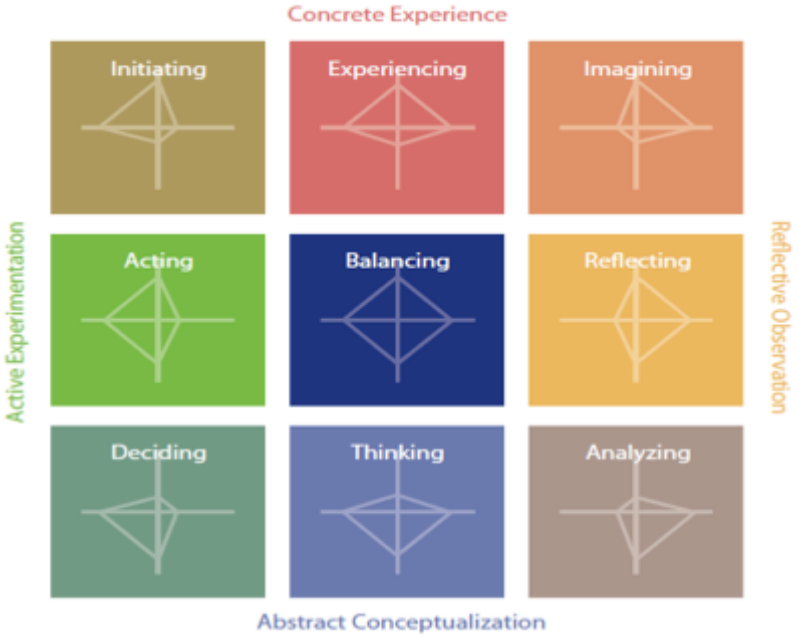



Figure (19): The Nine Learning Styles in the KLSI 4.0

Finally, all the above assessments and testing tools are meant to be for individual guidance. Worth mentioning that understanding one's self is never a finished product and that personal and self understanding evolves by time. An individual who strives to better understand himself, should look at the different dimensions of self awareness to ensure he matches his personality, interests, skills and values with the career options that he is exploring. The creators and designers of such tools alerted individuals or companies to use their own tools alone in hiring decisions. Such personal assessment tools are meant for development and guidance purposes. Personality assessments should only be an indicator and that many other factors are to be considered in the employment decision

(Warren, 2015; Guidelines for Hiring an Outside Consultant, n.d.; Hosie, 2017; Can I use DiSC for hiring or recruitment?, n.d.).

## 2.10 Conclusion

After reviewing literature regarding the impact of AI and its potential on both education and employment, as well as reviewing different education for employment frameworks, theories and case studies, this thesis attempts to close the gap in the research related to specific scope which is the impact of AI on education for employment. Young people can't find jobs. Yet employers can't find people with the required skill set. This mismatch between the supply and demand in the labor market might witness a bigger gap in the future with the growth of AI technologies. There are a few frameworks for education for employment or in other words "Learning and Employability". However the existing frameworks didn't address the potential of AI whether in terms of deployment of such technology within the framework or in terms of the implications of AI on the learning models or the employment models.

So there is a need to find a practical frame for learning and employability that incorporate the advancements of AI to facilitate the university to work transition. This thesis seeks to figure out the room for AI potentials through mapping innovative startups that embraced AI capabilities to play a role in the education for employment ecosystem.

# CHAPTER (3): Research Methodology

In this thesis, secondary data was used to achieve the objective of the study. The study follows mapping methodology which seeks to identify and analyze AI-enabled startups, corporates and/or projects that initiated solutions to address the learning and employability gaps. In order to achieve a compelling map, below are the phases of the search process:

1. Desk research on the current learning and employability frameworks
2. Desk research on the AI applications in learning and employability and related startups
3. Desk research on the AI applications in recruitment and related startups
4. Mapping for entities that use AI within the learning and employability framework
5. Use and review couple of applications to have a deeper insights about how they worked, how was my personal experience and search for other users' reviews
6. Finally, analyzing data collected from the above phases and figuring out an innovative learning and employability framework that builds on the AI capabilities to learn, find complex patterns and propose more accurate insights that help students better choose their career, universities better serve and attract students and employers better select talents and accelerate their hiring process.

**Data Source:**

Data were obtained from different sources including;

1. Grey literature including white papers and reports published by development organizations (such as World Bank or ILO) or corporates (such as PWC) or consultancies (such as McKinsey & Company)
2. Crunchbase; https://www.crunchbase.com/
3. LinkedIn; https://www.linkedin.com/
4. Companies website
5. Product Hunt; https://www.producthunt.com/

**Inclusion criteria:**

1. AI Applications that are designed to address any component within the learning & employability framework covering: (Self awareness, Career guidance, Skills and knowledge building, and Jobs or opportunities matchmaking)

2. Companies, startups or even initiatives that innovate beyond the traditional solutions using AI technologies at their core
3. Entities that focus on the candidates as learners or job seekers

**Exclusion criteria:**

1. Any company that uses advanced technology or algorithm but not based on AI
2. Any company with business model that is based mainly on recruitment and helping employers

Some of the startups and companies that work in the matchmaking might be included if there is a clear focus, from those companies, on the learners and the job seekers, helping them explore themselves, explore opportunities that matches their preferences or profiles. There are no limitations in the scope of this study based on timeframe, region, or AI specific technology (whether machine learning, deep learning, natural language processing, speech or voice recognition).

**Study design:**

The research is going to cover 3 main learning and employability problems and looking for relative AI solutions:

1. Problem 1: Lack of self Awareness by learners accompanied by challenges in choosing their Career path
2. Problem 2: Acquiring skills in affordable, reachable and convenient way that matches the learner learning style, pace and personal circumstances
3. Problem 3: Assessing candidates/learners qualifications and accordingly individuals can hunt jobs that really matches their abilities and competencies

For each problem, traditional current solutions will be reviewed as well as the new innovative AI solutions. Afterwards a review will be conducted for such AI solutions in order to assess and analyze its impact on a social and economical level and a holistic review on the environmental level.

For each AI solution different search points will be looked for. Those points are:

1. The company or startup or initiative that innovated the solution
2. The founders of such companies and The scope of work
3. Where and when it was founded
4. What technology did they used
5. Their growth stage in terms of funding and employees

# CHAPTER (4): Impact of AI on Education for Employment

## 4.1 Introduction and Framework:

After reviewing literature regarding different education for employment interventions and successful implementations in different countries, an integrated framework can be structured, as shown in figure (18), in terms of 3 main pillars and a cross cutting ongoing intervention that intersect and enable decision making with each pillar. The 3 pillars are representing the 3 major interventions that job seekers pass by in his career journey.

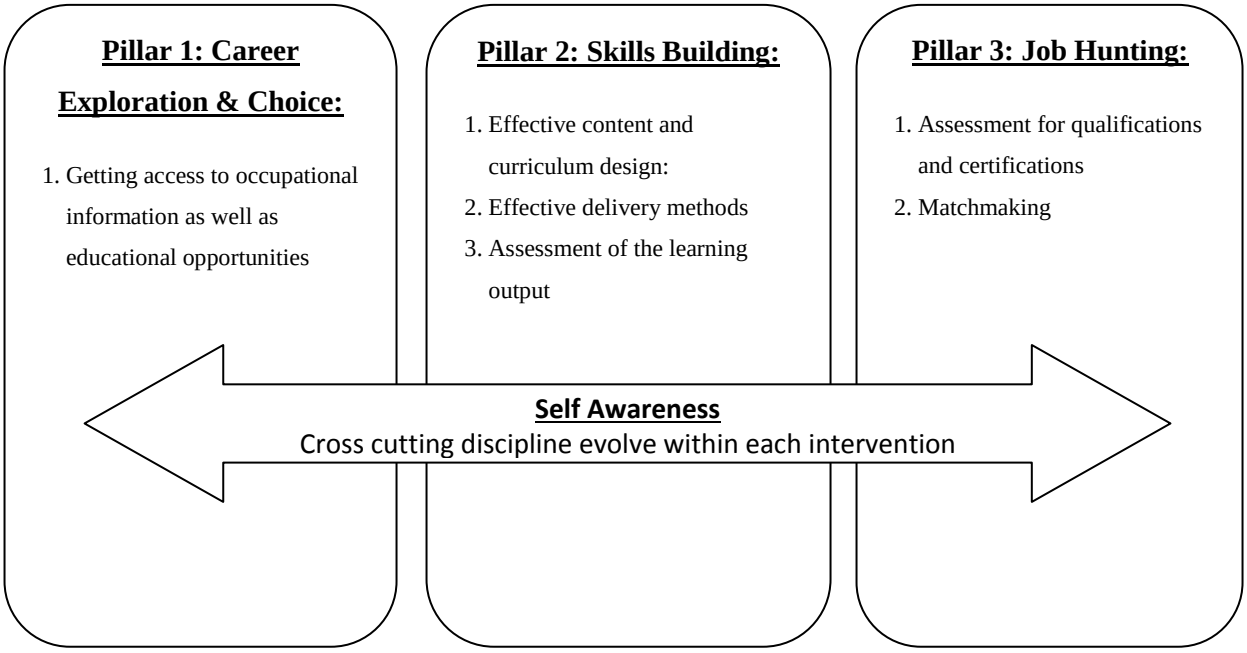



Figure (20): The main components of education for employment framework

Within the literature review, different examples of successful interventions were explored under each pillar. Those interventions represented the current solutions and endeavors done in a country or within certain context, some of them were out of the box and utilizes technologies to scale. Yet, all those interventions missed any kind of integration with AI. In the coming chapters study of how AI can add value to the education for employment process. Will AI bring different solutions that couldn't be achieved before?

The following table structures how each component in the education for employment framework is being addressed by current traditional solutions and how AI can bring difference.

| Problems to be solved | Current Solutions | AI Driven Solutions |
|---|---|---|
| Self Awareness & Career choice | Online & offline assessments that address personality, interests, values and skills. tests such as (MBTI, DISC or RIASEC) | 1. AI-eye scanning can assess personality<br>2. AI games that let people express their knacks ( traits and abilities)<br>3. Chatbots advise people about their career path |
| Acquiring Skills | 1. AMTEC model of very detailed content with strong employer engagement<br>2. Apprenticeship<br>3. Workplace simulation games<br>4. Serious games | 1. AI online interactive education that personalize learning tracks<br>2. Interactive material with augmented reality to bring subject to visual space<br>3. AI virtual learning assistant<br>4. Speech to text AI learning solutions |
| Assessment of qualifications and Matchmaking | 1. International certifications<br>2. Model of National Career Readiness Certificate<br>3. Digital Badges<br>4. Matchmaking platforms:<br>a. Traditional model such as Indeed.com and LinkedIn<br>b. Tinder-like style | 1. AI virtual assistants for profile building, resume review and ATS compatibility<br>2. neuroscience games powered by AI algorithms to match candidates<br>3. AI search engines that sort and categorize jobs from a wide range of job sites<br>4. AI chatbots for job recommendations<br>5. AI matchmaking platforms |

Table (4): Framework for the research and discussion

### 4.2 Impact of AI on Self Awareness & Career choice:

#### 4.2.1 Current solutions:

It was elaborated through the career diamond model that career decision and choice is done through a process of self understanding, and labor market exploration. Each component has its tools. So for the self awareness component there are the different personality assessment tests and each test assess part of the individual's self. The below table summarize the different types of assessments that can help job seekers better understand themselves.

| What needs to be assessed | Assessments |
|---|---|
| Personality & Behaviors | **MBTI** and **DISC** |
| Skills | **Gallup (Cilfton) StrengthFinder** |
| Interests | **RIASEC** and **Strong Interest Inventory** |
| Career Values | **Knowdell** Career Values Cards |
| Learning Styles | **Kolb** learning styles |

Table (5): Summary of personality assessments and their relevance

As for the market awareness component, there were two structured models implemented in UK and US:

- United Kingdom's National Career Service
- O*NET (Occupation Information Network) Program

There are additional resources for students and graduates to get updated about job market trends and career options, but they are scattered and don't aggregate data on a national or global level, however they are strong resources as well. Below are some useful resources for job market:

- Glassdoor:

  A leading job and recruiting site that offers millions of the latest job listings, with company reviews, salary reports, interview questions and reviews and more. All this data is collected from employees working within the employer itself so their data is trusted unlike other job sites (About Glassdoor, n.d.). Glassdoor in number:

  - 11+ million job listings

- 49+ million company reviews, salary reports and employers' insights
- 67+ million unique visitors monthly

- Indeed.com:

  #1 job search engine in the world with around 10 new jobs are being listed per second. Indeed shares more than 100 million ratings and reviews and 500 million salaries shared (About Indeed???).

- LinkedIn:

  LinkedIn is the world's largest professional social network, with more than 610 million users in more than 200 countries. LinkedIn not just provides jobs but also learning solutions for learners and hiring, selling and marketing solutions for corporates and employers (About LinkedIn, n.d.). For job seekers, they can find more than 20 million jobs on LinkedIn.

### 4.2.2 AI Driven Solutions:

**A. Personality assessment using eye movements**

In a recent research conducted by University of South Australia in partnership with the University of Stuttgart, Flinders University and the Max Planck Institute for Informatics in Germany, researchers found that eye movements can show four personality traits; Extroversion, Agreeableness, Conscientiousness, Neuroticism and curiosity. 42 students participated in this research. They wear eye trackers and were asked to walk around the campus for 10minutes and to buy any snack or drink of their choice from any of the campus' shops. After the walk around, participants are then asked to complete 3 personality questionnaires to assess neuroticism, extraversion, openness, agreeableness, conscientiousness, curiosity (Hoppe, Loetscher, Morey, & Bulling, 2018).

The study used computer vision machine learning method and eye-based user modeling. The findings of this study:

1) Personal traits such as “neuroticism, extraversion, agreeableness, conscientiousness, and perceptual curiosity” can be predicted from eye movements tracked during an everyday task
2) There is close link between individual's eye movements and his personality traits

However, there are different limitations and critiques for the study findings. The sample size, 42 participants, is too small to generalize the linkage between eye movements and personality traits or generalize it to non university students, or different age group. Also completing an errand in 10 minutes might not be enough compared to the usual daily activities that might unveil different behaviors. Different settings or real world activities might lead to different results. One of the major critiques to such study is that eye movements are highly susceptible to changes in the surroundings and environment (Orquin & Holmqvist, 2017). If the settings or activities changed, that might lead to different eye movement.

Additionally, the study included 3 questionnaires which participants may not be willing to genuinely answer the questions, rather providing desired or false answers. Moreover, using such findings might not be applicable, at least for now, in education for employment as the outcome covers only 5 traits which couldn’t be accountable in hiring decision or even guiding students for better career choice.

However, this study has paved the way in the field of personality research. Further studies needed with larger datasets, general population and including more personality traits.

On the other side, such exploration can be applied to robots in order to acquire some basic human behavior. Professor Andreas Bulling, who leads the Perceptual User Interfaces research group at the Max Planck Institute for Informatics, explained that building robots or systems that obtain such ability to mimic human behavior may communicate with human in a natural way and may also help people with nonverbal communication disorders to interpret others visual behavior (Max Planck Institute for Informatics, 2018).

Moving forward in such direction may enable creating robots, if acquired such understanding for eye movement versus traits, can help learners and job seekers know more about them self and guide them choosing their career.

However, such technology should be regulated as it might open lots of privacy issues. So on the social level, the data collected through gaze tracking can identify individuals as the gaze pattern could works as fingerprint. Moreover, the interests of the individual towards certain objects or displayed content on a screen can be recorded and abused revealing political, sexual and lifestyle preferences (Liebling & Preibusch, 2014).

### B. Game based analysis for personal traits and abilities

**Knack app**, a startup based in Silicon Valley, California, identifies person's knacks (traits & abilities) through games. Dashi Dash, Meta Maze or Bomba Blitz are 3 games designed by Knack app. It is surprising that these games look very similar to other games. Players just solve a maze or throw a water balloon or serve dishes to customers. While a person is playing one of their games, he or she performs many actions with a complex, real-time, immersive gaming experience. At the back of the game, thousands of data points are being collected. After the data collection, AI algorithms process the data and compute the players score. Scores are compared to certain threshold and accordingly the player awarded a specific "Knack".

The games were designed by a team of experts including Nobel Prize winner in Game Theory and Economics (Azulai, 2018).

The outputs of the games are classified into knacks, superknacks and ultraknacks. **Knacks** represents person's traits and abilities such as; dedication, reasoning, or self discipline. While **superknacks** are the one's potential in certain career. This doesn't mean that the person can work in this career field directly but it entails that he is good fit for that kind of work. And finally **ultraknacks** reflect one's potential in certain career in a specific employer which matches not only abilities but also company culture, leadership potential and others (Knack FAQ, n.d.).

Students and job seekers can use Knack app to identify promising career paths that best match with their abilities. Such app may let young people to discover knacks that match a certain career that they never thought about. Job seekers can use the app to connect instantly with employers looking for candidates with same talents and traits.

Games were used at different levels to explore potentiality of individuals. The US army designed a game called (America's Army) that was used in their recruitment campaign. Also the well

known hotel brand Marriot used hotel management game in its recruitment (Salim, 2015). Knack games was trusted by large corporates such as General Electric, AXA, Tata and Gap as well as educational institutions and development organizations such as MIT, The Rockefeller Foundation, Illinois Institute of Technology, and The World Bank (Azulai, 2018).

(Yee, 2016) collected data from 140,000 gamers and clustered their gaming motivations and argued that gaming motivations are related to key personality traits. So for instance if a person is an extrovert, he tends to score high in (action-social) gaming cluster.

One of the advantages of such games, that is back up with AI and big data analytics, is that it minimizing bias from both sides (the candidates and Employers). Candidates are just immersed in the game experience trying to perform the best. While employers just get real insights about candidates who are matching the required abilities, culture and potentiality.

### C. Chatbots can do career advising

**Wade and Wendy**, a startup founded in 2015, built conversational AI chatbots to improve the hiring process. From the name itself, the startup has two separate bots (**Wade and Wendy**). **Wade** is a personal AI-powered recruiter and career advisor. The chatbot **Wade** help individuals along their career journey, by discovering the best career path that works for them, suggesting new opportunities, recommending resources to develop skills and even remembering their application answers in order to reuse these answers in other applications.
Wade is similar to other chatbots in terms of technology as it uses a predefined scripts and natural language processing to answer questions and if the conversation elevated to a level that it didn't have answer from its knowledge, it direct the conversation to human operator and gradually learn from thousands of conversation to updated its knowledge and data set. The beauty of machine learning allows chatbots to learn on their own by recognizing the patterns of human interactions (Elupula, 2019).

While **Wade** helps candidates, it also supports **Wendy** in her work**. Wendy** is an AI hiring assistant. Employers submit information about their hiring opportunities and their preferences, and then Wendy engages potential candidates through personalized outreach, screens interesting talents and provides recommendations (Wade & Wendy, n.d.).

From an economical point of view, chatbots enhance the candidate experience which is one of the reasons 74% of candidates drop from the application process (Brablc, 2016). This percentage is huge and impacts the employment industry which was estimated to have generated €491 billion of sales revenue worldwide in 2017 (Economic Report , 2018).

From a social point of view, concerns are always raised on the possibility of replacing humans. AI powered chatbots can't really replace recruiters. Candidates need to understand employers' culture, negotiate salaries and sometimes to get the buy in for the offer (Porter, 2018). Instead, chatbot will take over the repetitive and administrative work from the recruiter allowing the recruiters to focus on the core. Chatbots can replace the employers FAQs, schedule interviews, build reports and assist in qualifying candidates (Osborne, 2018).

### D. Choose the university and course that matches you

Students not only face a challenge in choosing their career direction but the challenge even starts by choosing their academic direction or university. By 2025, OECD estimates that the total number of students that will be enrolled in higher education will be 263 million students with eight million students will be studying abroad (Tremblay, Lalancette, & Roseveare, 2012).

**BridgeU**, a startup based in London, empower schools to provide guidance to their students for choosing the perfect university and career for the future. The startup collects data about universities and all their courses and matches it, using intelligent algorithm, to student's social, career, and academic preferences (About BridgeU, n.d.).

**BridgeU**, the startup that was founded in 2013, currently partnering with schools in more than 50 countries globally enabling them with its machine learning and big data technologies (Butcher, 2017).

Another startup that is helping high school students is **Delphia.** The startup developed surveys that help student make important decisions such as choosing the best fit school or university. The recommendations are based on data from recent university graduates and if the student doesn't like this recommendation, Delphia use such dislike within its machine learning data sets to

enhance their recommendation outputs (Nazerian & Wan, 2018). The survey consists of 40 questions and the information collected from this survey is then processed by their AI engine to generate recommendations. The AI tool wasn't only inspiring for university partnerships, but also started to grab the attention of the media industry and the startup licensed its tool to the media company (VOX) (Lashkov, 2018).

Choosing certain faculty, major or even university is a hassle to students and their parents. Students suffer from peer pressures, parents' desires, or perceived social status attached to certain majors or faculties (Reddy, n.d.). With the emergence of such AI technologies and tools, students could receive data driven information that help them defining suitable tracks that matches their interests and career aspirations.

However, from a social point of view, AI powered surveys and recommendations could be useful but it might impose bias by AI itself. Rashida Richardson, director of policy research at AI Now Institute, believed that automated systems may lead to unintended bias as the training dataset might be composed of subjective judgments which in return affects the recommendations system (Pangburn, 2019).

On the other side, Kathy Baxter, architect of ethical practice at Salesforce, argues that AI technology can identify bias that creep into the machine learning process alerting any data that might emerge bias such as the last name or certain zip codes that could correlates with race for instance. Moreover, AI engines could get feedbacks to their output and recommendations if they included any sign of bias and this acts as a safeguard allowing the AI engines to learn as data flows to enhance their recommendations.

Gholipour (2018) argued that concerns will always be raised while discussing topics related to AI based recommendations, as the principle of "Garbage In/Garbage Out" is amplified in AI. The quality of the machine learning algorithm is highly depending on the quality of the data it gets trained on. Ongoing feedback loops might help in fixing biases generated from training data embedded with intended or unintended bias and calibrate the dataset.

### 4.3 Impact of AI on acquiring skills for employment:

#### 4.3.1 Current solutions:

There are lots of tools and solutions that were presented all over the world to help people gain knowledge and acquire skills. In the literature review, some successful models were shared and discussed for scalability. Below is a summary of the learning models including tech-enabled solutions that already scaled up:

1. Apprenticeship & summer internships
2. Building standard curriculum that is developed in partnership with employers from the same industrial sector; AMTEC model
3. Workshops within workplaces; Elsewedy Technical School model
4. Simulation based training; Nursing Skills Centre of Excellence model
5. Serious games; IBM INNOV8 model in universities
6. MOOCs; Massive Open Online Courses
7. Online courses developed by professionals, universities or corporates; edx, coursera, Udemy or Udacity model

All the above examples had evidence being successful for lots of cases. However, none of them includes adaptive learning technologies. Basically no two individuals learn the same way or at the same pace. Adaptive learning technology is part of personalized learning which uses data driven approach to not only show what a user or a learner wants to know but also it further shows what he needs to know to advance. Adaptive learning can adjust the learning path and pace of each learner which enables personalized learning at scale (Moskal, Carter, & Johnson, 2017).

#### 4.3.2 AI Driven Solutions:

**A. AI online interactive education that personalize learning tracks**

There are different startups that built AI adaptive learning technologies and get integrated with educational provider's platform such as **Fishtree**, **Knewton**, **Volley Labs**, **Sana Labs, Domoscio, Quizlet Learning** and **Century Tech.**

**Fishtree** empower teachers and educators to prepare and assign adaptive lessons for their students to enjoy a personalized learning experience. The system identifies student's knowledge gaps through assessments, generates analytics and recommends courses according to the learner needs not wants. **Fishtree** help teachers by sourcing content from open platforms like Khan Academy and YouTube, as well as from a teacher's own lesson plans. The content can be integrated with school's LMS and can be overridden by the teacher (Fishtree product review, n.d.).

Whereas Sana Labs, they recommend to each student learning path based on how he/she learn faster, how they forget and how they can stay engaged. Sana Labs also developed Sana Voice which is a product that uses AI speech recognition technology to help learners pronounce correctly, provide instant feedback empowering them to speak like a native (About Sana Labs, n.d.).

The learners' context has a great impact on the learning process. That's why **Aquinas Learning** addressed this gap and provides a context aware learning platform. So the right content pops up at the right time via the right channel. The startup that was founded in 2015 used AI natural language processing to interpret learners context by getting access to their work calendar, slack feed, project management tools or CRM entries in order to send their content at the right time. Content is sent to learners via voice, chat and simple micro-learning tips to ensure receiving content through the right medium.

Sharples, Taylor, & Vavoula(2005) believed that mobile learning facilitates learning across and within contexts and took the learning out of a computer and a table. However context is not only physical but also emotional, mental, and social. Small change in the learning settings can be distracting such as level of noise and congestion in workplace (Malamed, 2018). Another concern related to accessing workplace data, in order to generate adaptive learning at the right time, is about privacy. Consumers just "Accept" the lengthy user agreements which take their data to huge analytics engines. The analytics are useful for personalized recommendations but the risks associated to such exposed personal data are not trivial (Forbes Insights, 2019).

At the end, all such adaptive learning AI solutions are tools that can be used by educational institutions and career development companies to create and manage technical, vocational and

industry specific content while having the visibility of learners' performance and knowledge gaps.

### B. Interactive material with augmented reality to bring subject to visual space

Augmented reality has been evolving over the last few years bringing new potentials for different industries. Education is one of the fields that is being invaded by AR. So what's augmented reality? And how AR is changing our education ecosystem? What can the merger between AI & AR bring?

Augmented reality (AR) is a technology that allows computer-generated digital information to be overlaid on top of real objects once the lens of a smartphone, or tablet pass over this object (Naik, 20118). In education, AR empowers students with extra digital information about any subject regardless of its complexity and changes their learning experience to be more fun, visualized and engaging. Imagine a student is doing his homework and can scan elements in his book then receive text, audio or video tips from his teachers. A student who wants to learn more about certain career or function can have a virtual practice with simulations and access augmented tutorials. In fact, AR can bring fun, engagement and life changing experience to learners.

AI enhances AR by bringing additional capabilities that create multidimensional virtual experience. Adding image recognition, object detection and tracking, eye tracking, voice recognition and other AI technologies to AR can allow more responsive space so users can manipulate objects with their hands, eyes and sound (Mejia, 2018).

One of the successful startups that brought together AI & AR in education is **Blippar**. With the increase of gig economy and the need for employees with diverse skill set, instant visual learning AR/VR tools can help in building the required skill set. **Blippar** help learners using their smartphones to get instant training on certain tasks by just aiming their phone's camera at a company's products or machines. Learners can see a 3D engine inside out, rotate it, check their parts and learn how to assemble or disassemble each component. **Blippar** solutions can bring new levels of on the job training. Cisco, the world leader in IT and Networking, used **Blippar's** AR creator to let technicians access virtual instruction instantly from their devices allowing

them, for instance, to understand how to install certain spare parts through displaying an AR overlay on top of the device. Such solutions reduced technicians' need to read long manuals, increasing installation efficiency by 30% (Sharma, 2018).

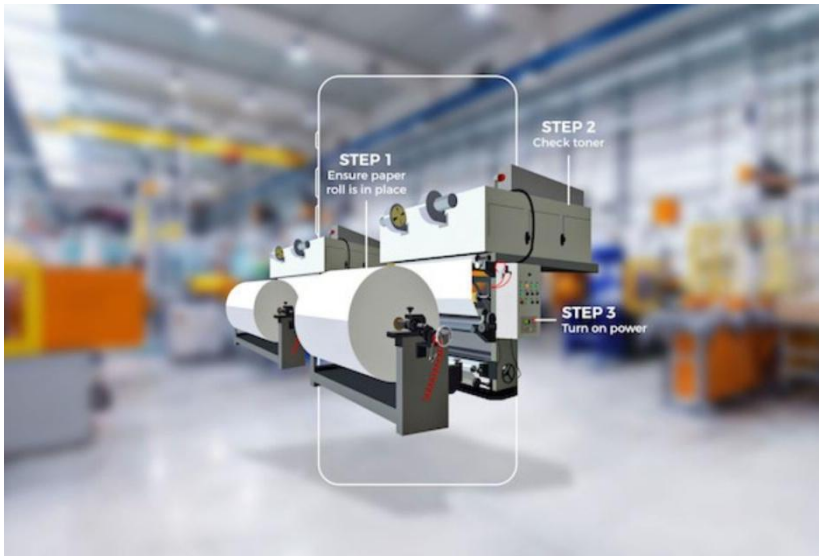



Figure (21): AR demonstration for machine commissioning

**Blippar**, the startup that was founded in 2011 in London, has now over 65 million app downloads (EMEA Winners, 2016), and recognized as 'Best App for Virtual or Augmented Reality' at the Global Mobile Awards 2017 (Global Mobile Awards, 2017).

### C. AI virtual learning assistant

Within any learning process, learners would love to get assistance, guidance, feedback and having engaging experience. **Cognii**, a startup founded in Boston in 2013, developed Virtual Learning chatbot that engages students in a conversational learning process by enabling them to construct an answer, providing assessment, providing personalized hints and tips, and guiding them within their learning process. The chatbot allow students to:

- Build an open response with their own expressions not only guided by the multiple choices
- Receive feedback on their formative assessments
- Be guided in an engaging conversation
- Get personalized adaptive learning path tailored for each student

**Cognii** has been selected as the 2016 winner from the Mass Technology Leadership Council (MassTLC) as the most innovative companies transforming the New England economy. And recognized as one of the few leading vendors for AI Market in Education from market research firm; Technavio (Cognii Virtual Learning Assistant, n.d.). Unlike Virtual assistants and chat bots such as Siri, Alexa, Cortana and Google Assistant that are built for general purpose assistance, **Cognii** Virtual Learning Assistant is designed and optimized for educational conversation.

One of the ethical concerns that has been raised related to chatbot, and it applies on **Cognii** as well, is that users don't always know if they are chatting with human or a bot which impose an ethical question regarding giving a false impression to customers who assume they are interacting with human (Botelho, 2017). Similar to Duplex, New Google assistant, which learnt to add speech pauses such as "Umm, or Mmmm" to sound more human. It's impressive but open hot topic about the evolution of such technology and its implication (O'Brien, 2019). At least, letting users know up front that they are talking to a bot through an onboarding message or just mention the word "bot" beside the chatbot name. Such way won't deceive users.

### D. Speech to text - AI Learning solutions

Speech to text or voice or speech recognition is simply the technology of recognizing voice and allowing commands between an individual and computer using the personal voice. Voice recognition has evolved with more fast and accurate outputs that enabled different uses within the educational sector. Dittrich and Star (2018) noted two main uses;

- Instant Note Capture (INC)
- Store voice to text records

Instant Note Capture voice recognition technologies has evolved to be more capable of doing more actions such as typing or editing, email writing and performing voice commands. **Naunce**, a company founded in 1992 in Massachusetts, developed a tailor product for educational services called "**Dragon**". **Dragon** allows students, especially those who struggle with writing, to express themselves by talking instead of writing. Learners, after installing Dragon software on their computers, can now use their voice to:

- Do computer commands such as opening a file, search for something or even close the computer
- Send emails or instant messages
- Dictate documents
- Search the web

Dragon, similar to machine learning technologies, gets smarter as a learner uses it. It learns and adapts to users voice and the words and phrases he or she uses often. Using Dragon enhances the speed and accuracy of the learner's writing skills as well as his computer skills (Dragon Speech Recognition for education, n.d.).

Stored voice to text records becomes an affordable and real-time tool for students and learners to access lectures and classrooms' notes at their convenience. Tulane University, Western Kentucky University, and UCLA have utilized "**Otter**" a voice recording app developed by San Francisco startup **AISense**. **Otter** allows users to transcribe speeches, capture meetings' conversations and record interviews, and conferences in text. Otter can recognize who is speaking, search and extract keyword, separate between different speakers and generate a unique voice print for each individual. Transcriptions are then processed over cloud servers and can be accessed by Otter's mobile app or over web (Wiggers, 2018).

Goddard( 2018) shared general concerns regarding speech to text technology especially related to the delay of the system to familiarize itself to the users' unique speech patterns which may take from few minutes till hours. In addition to the need for stable and fast internet connections which again might not be accessible for all users. However there is an interesting side effect related the dependency of young generations on screens. Such dependency on screens is a continuous concern to parents regarding its potential health risks on their sons.

## 4.4 Impact of AI on qualifications' assessment, job search, job application assistance and matchmaking:

### 4.4.1 Current solutions:

The job hunting dilemma is time consuming process and incorporate lots of hassles and uncertainty for job seekers and it encompasses two main major challenges: first is how candidates can show off their competencies in a credible way for the employers and second is

how they can find the best matching jobs for their qualifications. Both challenges combined as well in front of the employers who suffer from the skill mismatch and accordingly this impact their staffing plans, hiring budgets and time lost in searching for the right candidate which sometimes, according to Monster.com insights, might reach 4 months to complete the hiring process (Rossheim, 2017).

Employers usually follow a recruiting process that can be described as a funnel; in which large pool of visitors explore employers' career website, then a portion of those visitors actually apply; those applicants pass by a pre-hiring assessments that are usually online, afterwards a smaller subgroup get interviewed, and finally one or two individuals are fit to the role and receive an offer (Shetelboim & Hsu, 2018). Candidates usually get prepared for this recruitment process through the following steps (not necessarily in sequence):

1) Show their qualifications, training and skills through preparing their CVs or resume
2) Search and apply for jobs and internships through all known channels for them
3) Get prepared for the interview by asking advice, accessing info online or getting enrolled in a course

Step one depends not only on the skills and qualifications of candidates but also on how the candidates show it. Lots of studies revealed that HR professionals take only 7 seconds on average while reviewing a CV (Moore, 2019; Giang, 2012). So candidates are challenged to grab the attention of the recruiters within 6-7 seconds and they tend to use online CV templates or attend a session to know the tips and tricks or use an online CV builder. **Novorésumé**, a startup in Copenhagen founded in 2014, helps candidates build resumes that stand out with creative and professional layout (Novoresume, n.d.).

Another alternative that candidates started to try video recorded like cover letters in order to be able to show their potentials outside the 2 pages CV. **Jobzmall**, a startup founded in 2016 in California, introduced their "Seamless Video Apply" tool on their platform where candidates can build their profile, similar to other job sites, but add a recorded video about themselves, giving them the opportunity to show off their qualification (About Jobzmall, n.d.).

While in step two, according to reports from careerbuilder.com; 70% of employers use social media to reach out job candidates for hiring (Hayes, 2018), so candidates simply follow

employers on social networks and tag their friends whenever they find a good job post or they build a profile on one of the known job sites such as **indeed.com, glassdoor.com, monster.com or linkedIn.com.**

And finally the third step which is a longer term stage, where candidates build their skill set that enable them to get hired and perform at their best. This stage is likely to be part of pillar two that is related to acquiring skills.

### 4.4.2 AI Driven Solutions:

#### A. AI virtual assistants for profile building, resume review and ATS compatibility

Employers, especially the top corporates such as P&G, Unilever or Microsoft, do possess an applicant tracking system ATS. Almost 90% of Fortune 500 Companies use an ATS to handle the hiring process online by filtering, and organizing job applications (Vishwakarma, 2018). Candidates strive to beat this system and allow their application to stand out.

**Mosaic** addresses this challenge with an AI assistant that helps applicants craft their resumes by figuring out which keywords to use and what traits companies are looking for and accordingly edit resumes and find the strengths and weaknesses in the applicant profile with reference to the job post. Big corporates post their jobs on their own applicant tracking system ATS which basically screen the candidates profile looking for specific keywords. So **Mosaic** aggregates jobs from different sources, creates a job list and candidates who wish to apply for a certain job, Mosaic compares the applicant resume with the job description, edits the wording to match skills and enables the users to plan their careers based on trending keywords (Mosaic; How it works,n.d.). In another words, this AI assistant will help candidates pass the pre-hire online resume screening phase (Matthews, 2017).

Another interesting solution for profile building is **Skillroads**, a startup based in California. They have created an AI resume generator where a job seeker enters his or her job preference/titles then answers a small questionnaire about previous experience then their AI engine sources smart data from different sources to identify the candidates' skills and interests and afterwards, skillroads AI bot creates a powerful resume. Moreover, they created a smart resume review that

observes any gaps in the resume and check the compatibility of the resume towards how ATS works. Finally, Skillroads also aggregate job opening from Fortune 500 companies so users can notice and apply for (Skillroads, n.d.).

In general, CV builders bring lots of benefits for job seekers and employers. Job seekers are able build more professional resume with lots of modern design choices, save time and effort, and inspire them to mention things about their experiences and accomplishments that they might not know it should be written. On the other side, employers receive better resumes, well structured, easy to filter and review and most importantly with better ATS matching pipeline. The drawbacks of such tools (CV builders) are related to the generic "look alike" feel that will requires the job seekers to really differentiate themselves versus others through stronger skills and knowledge. For young individuals who are starting to look for an internship, they might find it not good for them as they might find couple of sections with no data to provide so this leads to big gaps in the resume (Brodsky, 2018).

While reviewing lots of online CV builders, one of the missing options, even with the power of AI, is that a candidate can't add a new section to his resume. For instance, if a candidate has published number of papers, he might wishes to dedicate a section in his resume to demonstrate such strength point. Such option isn't available at least till now.

### B. AI powered neuroscience games for assessment and matchmaking

**Pymetrics** developed neuroscience games that are designed to collect behavioral data using neuroscience exercises that measure cognitive and emotional traits. They used games to detect these data rather than just asking candidates to answer different questions and thus trying to remove bias from both sides. This approach allows employers to access personal profiles that are much more accurate and based on traits and behaviors. The games last for 25 minutes only and results are measured against 77 cognitive social and emotional traits.

Employers that are interested in using such hiring tool, ask their existing top performer employees to play pymetrics neuroscience games allowing deep analysis for trait data and trends, then **Pymetrics** build a custom profiles for each role in the employer which means that a candidate can match the role profile in one company but doesn't fit the same role in another

company. These machine learning algorithms updated regularly with new performance data submitted from the employer. So now candidates who want to apply for a job will play games and match to opportunities. In order to avoid manipulation by candidates, each applicant can just play the games once per year. Within each game, applicants can't pause, they can only take breaks between each game and the other (Pymetrics, n.d.). Traditional personality assessments rely on candidates' ability to describe themselves which might lead to potential distortion which can be reduced by gamification (Walters, 2015). Another advantage of gamification, is that candidates, while immersed in the gaming experience, can hardly fake their reactions.

From an economical point of view, such games when introduced to the recruitment process can reduces time for the candidates looking for his best match and for the employers in screening job applications. Additionally, it frees up valuable time for the hiring managers, increases engagement and definitely reduces human bias (Acuna, 2018). For these reasons, Pymetrics succeeded to convince big corporates such as LinkedIn, Unilever, Accenture, and Tesla to use their quizzes and games in their hiring process (Ryan, 2018).

From the social angle, there is a clear threat of social deprivation. Usually games are done online and remotely, so candidates who can't have access to internet connection can be disengaged from the hiring process (Walters, 2015). There are lots of debates from candidates who have been involved in hiring process using Pymetrics games. Kits Arriet, one of reviewers of Pymetrics games, stated that the recommended job categories are too broad, generic and that the most interesting field for him, which was STEM Research, was 44% match. Others who believed their profiles were really matching some job opportunities, were rejected because of the mismatching results from Pymetrics games ("Has someone tried Pymetrics? How true is it for you?", 2017).

**Arctics Shores** also designed gamified assessments that are a more engaging and immersive alternative to traditional psychometric tests. One of their most used games is "Skyrise" in which candidates are placed in a futuristic office challenged to do some tasks where 33 personality and cognitive traits are being measured through 3000 data points that being collected from candidates through their approach and decisions they take to accomplish a task (Arctic Shores Solutions, n.d.). Siemens started to use Arctic Shores game based assessment in their early stage selection

and from the first years results were very promising in terms of conversion rates, diversity and retention rates as well (Butler, 2019).

From a social angle, Arctic Shores has designed their games to accommodate individuals with disabilities or color blindness and if a candidate is afraid that his disability will still affect his/her game performance, he/she can contact Arctic Shores team for support (Career Unlocked: A PwC Game-Based Test, n.d.). Another concern related to bias against "unexperienced or non gamers", which isn't really applicable to such recruitment games cause there is not scoring. It's not measuring someone performance versus others but it only measures their own personal approach and decisions. Moreover, it increases female engagement who represents more than half of the gamers world wide according to the Entertainment Software Association (Wallace, 2019).

### C. AI search engines that sort and categorize jobs from multiple job sites

When a company like **Google** enters a market, you can expect more. **Google** is leading a change in the job hunting experience by launching its new job search product "Google for jobs". **Google** intends to use its high-end machine learning sophisticated system, which was used to sort and categorize information on web, to search suitable jobs from huge sources including employers' job sites, big or small, as well as the known job board like monster.com, glassdoor.com or linkedIn.com. Actually Google is going to partner with already existing job boards, such as LinkedIn, Glassdoor, and Monster. (Riley, 2018).

The idea is to make "Google for jobs" the AI-based middle-man for these job sites, and aggregate thousands of job posts from across the internet. Once a job seeker finds a job, **Google** will lead the applicant directly to the job source site to start the application process. The algorithm directs the candidate to the most complete and detailed post source in case the same job is listed on two or more sites.

There is no special URL for "Google for jobs" but job seekers will use the regular Google search box by typing any job related search query such as "jobs near me" or "find me a job". Differentiated search results will appear on top of the search page with blue header as shown in the below figure.

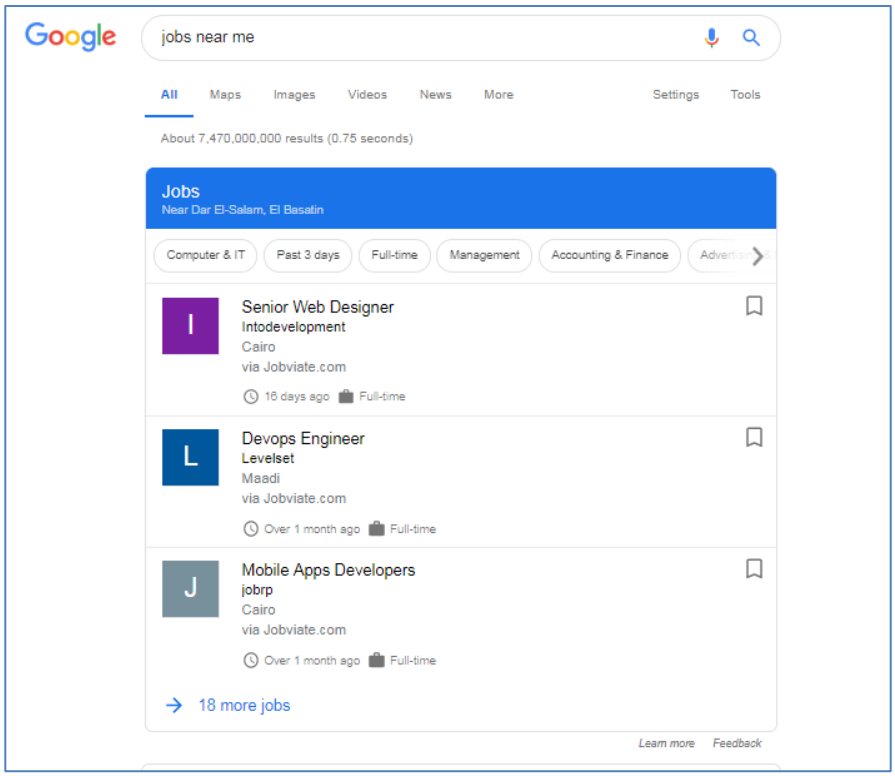



Figure (22): "Google for jobs" new feature in Google search

The search tool includes filters like commute time and the number of hours a candidate wants to work. The tool includes salary-range estimates, jobs ratings and reviews for the employer.

"Google for jobs" helps candidates to disregard the hassle of searching for jobs and also promote the job listings for employers and other job sites.

### D. AI chatbot for job recommendations

**Other contributors to the job search and opportunities' recommendation are chatbot. One of the chatbot developers is Newton, a startup that developed** AI assistant/chatbot that candidates can text and it will continuously search the web for jobs that match the candidate's profile using natural language processing technology and send them recommendations for new jobs. The AI engine uses deep learning algorithms to learn more as it receives candidate's feedback regarding the job recommendations. Candidates can directly text the chatbot on Facebook messenger or upload their resumes and the job search starts avoiding any job search

hassles and candidates can apply directly to the most interesting job openings at a push of a button (Newton Home page, n.d.).

**Jenna** also is a chatbot pretty similar to **Newton** but with three main differences:

- Employers should connect Jenna to their Facebook page so they become able to share a link to Jenna on any channel including Facebook, your website and other.
- Employers add screening questions and Jenna utilize its AI NLP technology to match the best candidate through his answers
- Employers can integrate Jenna with their ATS systems for synchronization

**Wade & Wendy**, the chatbots, which were mentioned earlier, **Wade** helps candidates as a career advisor while **Wendy** does the matching. **Wendy** is an AI hiring assistant that helps employers by collecting hiring information, outreaching to potential candidates, and screening the most matching applicants to suggest recommendations for the employers (Wade & Wendy, n.d.).

### D. AI - Powered matchmaking

The power of AI brings not only chatbots, games, or even huge searching algorithms but also disruptive technologies that startups been able to capture and use to facilitate the hiring process and the matchmaking cycle in a totally different way. Below are some startups that led the way in transforming the recruitment industry.

**Stella** is a shared talent network or in other words a job marketplace powered by AI. Candidates fill only one application that is used to apply in all jobs without the hassle of filling job applications. Employers only see job applicants that match their requirements. Employers can invite strong match candidates if they didn't apply allowing the employers to reach out for large talent pool. After the matching is being done, applicants answer specific questions related to the job and afterwards their profile as well as their enhanced resume are directed to the employers ATS where the employers continue their hiring process but with the top match talents, saving time for reaching out talents and resume screening (About Stella, n.d.).

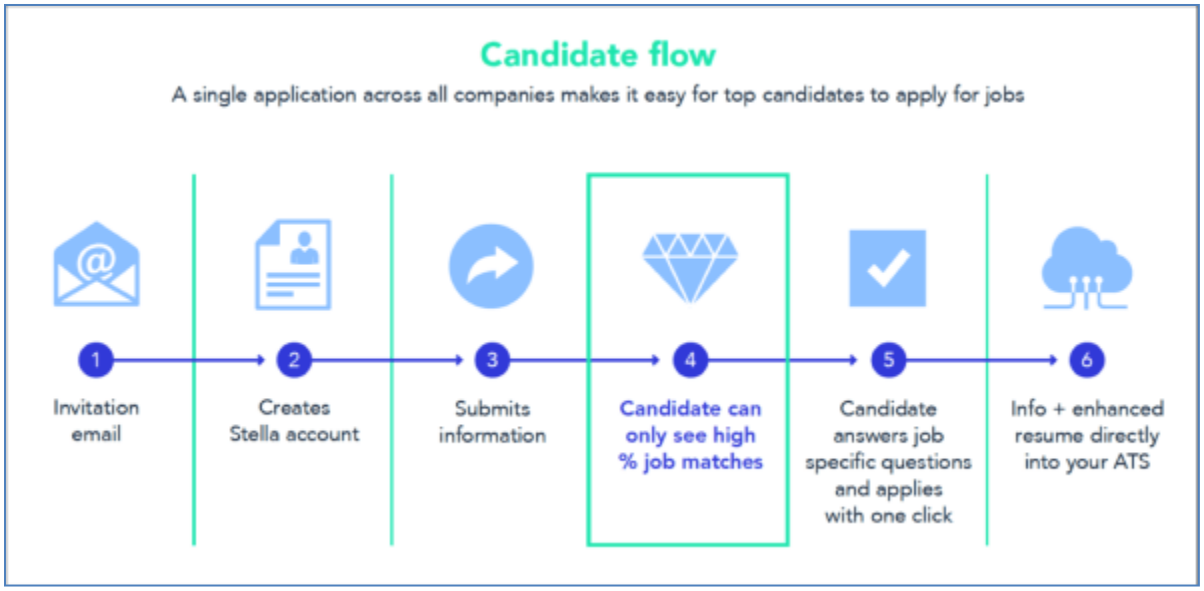



Figure (23): Candidate flow on Stella.ai

Stella marketplace allows only candidates who are based in US to apply. One of the good social points that Stella addressed in their product design is the option of keeping the privacy of job seekers by ensuring no one can view the candidates job hunting status except companies that the candidates had applied for.

In an interview conducted with Adam Zoia, Co-Founder of Stella, he mentioned that around 100 major organizations, including Unilever, Hilton and Rackspace, have used Stella. He added that some companies had received over 10 million applications on certain open job over a year from their marketplace (Dishman, 2017).

Stella only works in US. If an applicant doesn't have a US phone number, he/she can't access the job opportunities. Number of candidates reviewed Stella as it is interesting to use such a tool trying to get them placed in another opportunity after they got rejected in one or two companies. But the actual concern was; is it efficient or not? And how effective is the AI?

**Gloat** is an career development platform powered by AI. Gloat chatbot asks new candidates some questions about their career history, skills and career goals. Accordingly it creates an anonymous candidate profile and matches it with the relevant career opportunities. Employers review the anonymous profile and if they like the profile, a notification is sent to the candidate so he can decide whether he is interested or not and then start direct conversations with the

employer (Gloat Marketplace, n.d.) Their platform and app are designed in a Tender-like experience where employers and candidates just appear to each other if there is a match and conversation starts if there is a common interest ("Most Innovative Companies; Gloat", n.d.).

What's interesting about both platforms (Stella & Gloat) is that candidates just build their profile once and they just get notified about matching career opportunities. This process saves time for the candidates in searching for jobs and filling multiple job applications. In addition to keeping the candidates profile anonymous which ensure privacy and confidentiality of the job hunting status of the candidates.

However, it's too early to assess the effectiveness of such matching platforms. In 2014, Amazon tried to build a system to analyze resumes and recommend the best fits. In 2017 the project was closed due to a pattern of bias was found against the word "women". Although Amazon engineers tried to fix that but they couldn't as the algorithm was trained on historical 10 years data of the company's hiring data (Gershgorn, 2018).

### 4.5 Further Analysis and Discussion:

After studying the different examples of how AI can bring innovation and disruption to education for employment ecosystem, there was found 48 companies that contributed to this domain. Only 3 out of the 48 companies were corporates that either acquired a startup in that domain and integrated its services or launched a new product. This means that 94% of the companies which innovated an AI powered solution used in "education for employment", were startups. Table (6) shows the list of the 48 companies and startups, and their scope of work.

| # | Startup name | Scope | Description |
|---|---|---|---|
| 1 | Knack | Self Awareness + Career Paths (Games) | Neuroscience games to discover my traits and knacks and accordingly recommend matching career fields |
| 2 | Wade and Wendy | Self Awareness + Career Paths (Chatbot) | Chatbot learn individual preferences and suggests resources and opportunities |

| | | | |
|---|---|---|---|
| 3 | BridgeU | Self Awareness + Career Paths (University Selection) | Intelligent platform that collects data about universities and all their courses and matches it to student's social, career, and academic preferences |
| 4 | Delphia | Self Awareness + Career Paths (University Selection) | Helps students choosing the best fit school or university through questionnaire that matches recommendations from recent graduates of the same school |
| 5 | LinkedIn Learning | Learning (Adaptive Learning) | professional networking site, allows its members to create business connections, search for jobs, and learn |
| 6 | Fishtree | Learning (Adaptive Learning) | an adaptive learning technology provider |
| 7 | Knewton | Learning (Adaptive Learning) | an adaptive learning technology provider |
| 8 | Volley Labs | Learning (Adaptive Learning) | an adaptive learning technology provider |
| 9 | Sana Labs | Learning (Adaptive Learning) | an adaptive learning technology provider |
| 10 | CENTURY Tech | Learning (Adaptive Learning) | an adaptive learning technology provider |
| 11 | Domoscio | Learning (Adaptive Learning) | an adaptive learning technology provider specialized in Big Data for learning |
| 12 | Quizlet | Learning (Adaptive | an adaptive learning technology provider |

| | | | |
|---|---|---|---|
| | Learning | Learning) | that uses activities and games to help students practice and master what they're learning |
| 13 | Aquinas Learning | Learning (Adaptive Learning) | an adaptive learning technology provider offers context aware learning delivery solution for corportes that is focued on mobile learning through flashcards, chats, or voice |
| 14 | Blippar | Learning (Augmented reality) | technology company specializing in augmented reality, artificial intelligence and computer vision |
| 15 | Cognii | Learning (Chatbot & Tutor) | Virtual Learning Assistant for tutoring conversations and assessments |
| 16 | Naunce | Learning (Speech to Text) | Developed "Dragon" that allow users to express themselves by talking instead of writing. Also do compputer commands, dectate documents and serach web |
| 17 | AISense | Learning (Speech to Text) | Developed "Otter"; voice recording app that transcript lectures, meetings and conversations |
| 18 | Mosaic.ai | Matchmaking (Profile building) | Career agent suggests the best career opportunities based on the candidates skills. Allow users to edit their resume wording to match kob skills |
| 19 | Skillroads | Matchmaking (Profile building) | Progressive AI Profile and CV Builder |

| | | | |
|---|---|---|---|
| 20 | Pymetrics | Matchmaking (Games) | develops neuroscience-based assessment and prediction technology for staffing services |
| 21 | Arctics Shores | Matchmaking (Games) | global provider of gamified psychometric assessments |
| 22 | HireVue | Matchmaking (Games) | Hiring Intelligence Platform delivers the best talent, faster with video interviews and AI-driven pre-hire assessments |
| 23 | Google for jobs | Matchmaking (Job Search Engine) | Giant Job search enngine that aggregates jobs from multiple job boards and sites |
| 24 | Newton | Matchmaking (Chatbot) | a personal job search assistant |
| 25 | Jenna | Matchmaking (Chatbot) | SaaS AI driven solution that automatically questions and screens candidates allowing better hiring process |
| 26 | Xor.ai | Matchmaking (Chatbot) | chatbot Recruitment Communication Automation |
| 27 | Impress.ai | Matchmaking (Chatbot) | conversational bots autonomously screen, interview, engage, and shortlist candidates 24/7 |
| 28 | Jobpal | Matchmaking (Chatbot) | AI-powered chatbots for the recruiting and talent acquisition use case that automate the communication between employers and candidates |
| 29 | Hazie | Matchmaking (Chatbot) | Cutting Edge Job Placement Bot |

| | | | |
|---|---|---|---|
| 30 | Gecko | Matchmaking (Chatbot) | Leading AI-based Video Interview Bot to Leverage Video Intelligence for Candidate Insight and Selection |
| 31 | Trustifyai | Matchmaking (Chatbot) | Career Robo Advisor™ improves Trusts & hiring confidence between talented Candidates and reputable Employers |
| 32 | Aircto | Matchmaking (Chatbot) | Human and AI powered hiring platform and chatbot |
| 33 | Ideal | Matchmaking (Chatbot) | provides talent intelligence for high-volume hiring. Ideal uses AI to centralize rich candidate data and screen candidates. |
| 34 | Stella | Matchmaking (Platform) | Shared talent network - AI Job Marketplace. |
| 35 | Gloat | Matchmaking (Platform) | AI-based anonymous career development platform allowing users to both know their worth and get concrete offers in real time. |
| 36 | Mya | Matchmaking (Platform) | leading conversational AI platform for hiring teams |
| 37 | Deepersense | Matchmaking (Platform) | AI Profile builder that predicts the candidate's personality, culture fit and potential behavior as an employee |
| 38 | Cut-e | Matchmaking (Platform) | innovative online tests, questionnaires and gamified assessments. |

| | | | |
|---|---|---|---|
| 39 | Empirical Hire | Matchmaking (Platform) | Build profile based on behavioral assessments and match it to fitting positions |
| 40 | Karen.ai | Matchmaking (Platform) | Cognitive recruiting assistant |
| 41 | NoviOpus | Matchmaking (Platform) | develops the next generation of recruitment and finding a job systems |
| 42 | GrabJobs | Matchmaking (Platform) | Web / Mobile Recruitment Solutions powered by Interview Chat Bot technology |
| 43 | Intervyo | Matchmaking (Platform) | World's first automated interviewing system, that screens candidates for recruiters and accurately predicts job suitability. |
| 44 | Hiretual | Matchmaking (Platform) | AI-driven recruiting technology company |
| 45 | Eightfold | Matchmaking (Platform) | Helps employers and recruiters hire faster using AI recruitment technologies |
| 46 | Arya | Matchmaking (Platform) | Recruitment automation platform designed to empower recruiters with AI. |
| 47 | Hirehunt | Matchmaking (Platform) | Helps employers and recruiters hire faster using AI recruitment technologies |
| 48 | recruitment Smart | Matchmaking (Platform) | Helps employers and recruiters hire faster using AI recruitment technologies |

Table (6): List of companies with their scope of work

The following table shows who were behind those companies, when and where they started

| # | Startup name | Scope | Founders | Founding Year | HQ Location | Countries |
|---|---|---|---|---|---|---|
| 1 | Knack | Self Awareness + Career Paths (Games) | Guy Halfteck | 2012 | San Francisco, California | US |
| 2 | Wade and Wendy | Self Awareness + Career Paths (Chatbot) | Adrian von der Osten, Drew Austin, Ian Jaffrey, Joshua Brandoff | 2015 | New York | US |
| 3 | BridgeU | Self Awareness + Career Paths (University Selection) | Hywel Carver, Lucy Stonehill | 2013 | London | UK |
| 4 | Delphia | Self Awareness + Career Paths (University Selection) | Andrew Peek, Cameron Westland, Clifton van der Linden | 2017 | Toronto | Canada |
| 5 | LinkedIn Learning | Learning (Adaptive Learning) | Allen Blue, Eric Ly, Jean-Luc, Konstantin Guericke, Reid Hoffman | 2003 | San Francisco, California | US |
| 6 | Fishtree | Learning (Adaptive | Jim Butler,Terry Nealon | 2012 | Dublin | Ireland |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Learning) | | | | |
| 7 | Knewton | Learning (Adaptive Learning) | Jose Ferreira | 2008 | New York | US |
| 8 | Volley Labs | Learning (Adaptive Learning) | Adam Ashwal, Carson Kahn, Marc Boxser, Ryan Orbuch, Zaid Rahman | 2014 | San Francisco, California | US |
| 9 | Sana Labs | Learning (Adaptive Learning) | Joel Hellermark | 2016 | Stockholm | Sweden |
| 10 | CENTURY Tech | Learning (Adaptive Learning) | Priya Lakhani | 2013 | London | UK |
| 11 | Domoscio | Learning (Adaptive Learning) | Benoit Praly, Bruno Praly, Ivan OSTROWICZ | 2013 | Paris | France |
| 12 | Quizlet Learning | Learning (Adaptive Learning) | Andrew Sutherland | 2007 | San Francisco, California | US |
| 13 | Aquinas Learning | Learning (Adaptive Learning) | Hugh Seaton, Mike Kobar, Rich Kuepper | 2015 | New York | US |
| 14 | Blippar | Learning | Ambarish Mitra, | 2011 | London | UK |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | (Augmented reality) | Jessica Butcher, Omar Tayeb, Steve Spencer | | | |
| 15 | Cognii | Learning (Chatbot & Tutor) | Dee Kanejiya | 2013 | Boston, Massachusetts | US |
| 16 | Naunce | Learning (Speech to Text) | Ronald Croen | 1992 | Burlington, Massachusetts | US |
| 17 | AISense | Learning (Speech to Text) | Sam Liang, Yun Fu | 2016 | San Francisco, California | US |
| 18 | Mosaic.ai | Matchmaking (Profile building) | Ed Windgate, Elena Windgate | 2014 | Seattle, Washington | US |
| 19 | Skillroads | Matchmaking (Profile building) | | 2017 | San Francisco, California | US |
| 20 | Pymetrics | Matchmaking (Games) | Frida E. Polli, Julie Yoo | 2013 | New York | US |
| 21 | Arctics Shores | Matchmaking (Games) | Robert Newry (CEO) and Safe Hammad (CTO) | 2014 | London | UK |
| 22 | HireVue | Matchmaking (Games) | Chip Luman, Mark Newman | 2004 | South Jordan, Utah, | US |

| | | | | | | |
|---|---|---|---|---|---|---|
| 23 | Google for jobs | Matchmaking (Job Search Engine) | Larry Page, Sergey Brin | 2017 | Mountain View, California | US |
| 24 | Newton | Matchmaking (Chatbot) | Helder Silva, Rui Costa | 2018 | Sunnyvale, California | US |
| 25 | Jenna | Matchmaking (Chatbot) | Lior Romanowsky | 2008 | Tel Aviv | Israel |
| 26 | Xor.ai | Matchmaking (Chatbot) | Aida Fazylova, Nikolay Manolov | 2017 | San Francisco, California | US |
| 27 | Impress.ai | Matchmaking (Chatbot) | Amrith Dhananjayan, Sudhanshu Ahuja, Vaisagh Viswanathan | 2016 | Singapore | Singapore |
| 28 | Jobpal | Matchmaking (Chatbot) | Andriy Martyniv, Christoph Gueldenberg, Luc Dudler | 2016 | Berlin | Germany |
| 29 | Hazie | Matchmaking (Chatbot) | Unknown | 2017 | South Africa | South Africa |
| 30 | Gecko | Matchmaking (Chatbot) | Siddharth Jhunjhunwala | 2000 | New York | US |
| 31 | Trustifyai | Matchmaking | Unknown | 2018 | Ontario | Canada |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | (Chatbot) | | | | |
| 32 | Aircto | Matchmaking (Chatbot) | Atif Haider | 2016 | Bangalore | India |
| 33 | Ideal | Matchmaking (Chatbot) | Shaun Ricci, Somen Mondal | 2013 | Ontario, Canada | Canada |
| 34 | Stella | Matchmaking (Platform) | Amrit Saxena, Oliver Brdiczka, Richard Joffe | 2016 | New York | US |
| 35 | Gloat | Matchmaking (Platform) | Amichai Schreiber, Ben Reuveni, Danny Shtainberg | 2014 | New York | US |
| 36 | Mya | Matchmaking (Platform) | Eyal Grayevsky, James Maddox | 2011 | San Francisco, California | US |
| 37 | Deepersense | Matchmaking (Platform) | Abhishek Vaid, Amarpreet Kalkat, Nishith Sharma | 2012 | Bangalore, Karnataka, India | India |
| 38 | Cut-e | Matchmaking (Platform) | Andreas Lohff and Achim Preuss | 2002 | Hamburg, Germany | Germany |
| 39 | Empirical Hire | Matchmaking (Platform) | Gal Sagy, Shiran Danoch | 2017 | Tel-Aviv, Israel | Israel |
| 40 | Karen.ai | Matchmaking (Platform) | Noel Webb, David Vradenburg | 2016 | Toronto, Ontario | Canada |
| 41 | NoviOpus | Matchmaking | Gilad Federman | 2015 | HaMerkaz, | Israel |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | (Platform) | | | Israel | |
| 42 | GrabJobs | Matchmaking (Platform) | Emmanuel Crouy, Mark Melo | 2015 | Singapore | Singapore |
| 43 | Intervyo | Matchmaking (Platform) | Jacky Hazan | 2014 | Tel-Aviv, Israel | Israel |
| 44 | Hiretual | Matchmaking (Platform) | Steven Jiang, Xinwen Zhang | 2015 | Mountain View, California | US |
| 45 | Eightfold | Matchmaking (Platform) | Ashutosh Garg, Varun Kacholia | 2016 | Mountain View, California | US |
| 46 | Arya | Matchmaking (Platform) | Madhu Modugu | 2012 | North Carolina | US |
| 47 | Hirehunt | Matchmaking (Platform) | Basel Fateen | 2015 | Cairo, Egypt | Egypt |
| 48 | recruitment Smart | Matchmaking (Platform) | Pawan Lokwani, Yusuf Jazakallah | 2015 | London | UK |

Table (7): List of companies with their founders, foundation year and location

Also below is shown the companies' growth stage in terms of funding and employees

| # | Startup name | Funds raised | # of Employees | Technology |
|---|---|---|---|---|
| 1 | Knack | Seed round | 54 | machine learning algorithms, smart video games, neuroscience, data science - Offers API integration |

| | | | | |
|---|---|---|---|---|
| 2 | Wade and Wendy | 11.5 | 35 | machine learning algorithms, chatbots, NLP |
| 3 | BridgeU | 8.2 | 54 | machine learning |
| 4 | Delphia | 4.1 | 28 | machine learning |
| 5 | LinkedIn Learning | Acquired by Microsoft | +15000 | Machine learning |
| 6 | Fishtree | Acquired by Follett Corporation | 7 | machine learning |
| 7 | Knewton | Acquired by John Willey & Sons | 136 | machine learning |
| 8 | Volley Labs | 7.3 | 17 | machine learning |
| 9 | Sana Labs | 2.5 | 55 | machine learning - API integration |
| 10 | CENTURY Tech | 2.7 | 61 | machine learning |
| 11 | Domoscio | 0.62 | 17 | Deep learning - API integration |
| 12 | Quizlet Learning | 32 | 151 | machine learning, gamified assessment |
| 13 | Aquinas Learning | 0.1 | 3 | machine learning algorithms, chatbots, NLP |
| 14 | Blippar | Acquired by Candy Capital | 63 | augmented reality, computer vision and machine learning |
| 15 | Cognii | 0.118 | 5 | machine learning algorithms, chatbots, NLP |
| 16 | Naunce | Public IPO | | Voice Recognition - speech to text AI - Deep learning |
| 17 | AISense | 13 | 25 | Voice Recognition - speech to text AI - deep learning |
| 18 | Mosaic.ai | | 3 | machine learning algorithms, |

| | | | | |
|---|---|---|---|---|
| | | | | chatbots, NLP |
| 19 | Skillroads | | 4 | machine learning algorithms, chatbots, NLP |
| 20 | Pymetrics | 56.6 | 133 | neuroscience games, machine learning |
| 21 | Arctics Shores | Seed round | 45 | Gamified psychometric assessments, predictive analytics and AI technology - Offers ATS Integration - Big data analytics combine thousands of in-app actions to form meaningful psychological variables |
| 22 | HireVue | 93 | 369 | machine learning, gamified assessment |
| 23 | Google for jobs | Public IPO | | machine learning |
| 24 | Newton | 0.4 | 32 | Deep learning algorithms, chatbots, NLP - FB messenger |
| 25 | Jenna | | 3 | machine learning algorithms, chatbots, NLP |
| 26 | Xor.ai | 2.2 | 26 | machine learning algorithms, chatbots, NLP |
| 27 | Impress.ai | 1.4 | 27 | machine learning algorithms, chatbots, NLP |
| 28 | Jobpal | | 24 | machine learning algorithms, chatbots, NLP |
| 29 | Hazie | | | machine learning algorithms, chatbots, NLP |
| 30 | Gecko | | | Computer Vision, image processing, machine learning, voice recognition, NLP |

| | | | | |
|---|---|---|---|---|
| 31 | Trustifyai | | | machine learning algorithms, chatbots, NLP |
| 32 | Aircto | Seed round | 11 | machine learning algorithms, chatbots, NLP |
| 33 | Ideal | 3 | 29 | machine learning algorithms, chatbots, NLP |
| 34 | Stella | Seed round | 33 | machine learning algorithms, chatbots, NLP |
| 35 | Gloat | 9.6 | 58 | machine learning |
| 36 | Mya | 32.4 | 81 | machine learning algorithms, chatbots, NLP - API integration |
| 37 | Deepersense | 0.44 | 22 | machine learning |
| 38 | Cut-e | Acquired by AON PLC | 181 | machine learning algorithms, NLP, gamified assessment |
| 39 | Empirical Hire | Seed round | 20 | Deep learning |
| 40 | Karen.ai | Acquired by Alexander Mann | 32 | machine learning algorithms, chatbots, NLP |
| 41 | NoviOpus | | 4 | machine learning algorithms, NLP |
| 42 | GrabJobs | 2 | 43 | machine learning algorithms, chatbots, NLP |
| 43 | Intervyo | 1.5 | 10 | Computer Vision, image processing, deep learning, voice recognition |
| 44 | Hiretual | 6.5 | 50 | machine learning algorithms, NLP - API integration |
| 45 | Eightfold | 51.8 | 74 | Deep learning - API integration |
| 46 | Arya | | 12 | machine learning |
| 47 | Hirehunt | Seed round | 9 | machine learning algorithms, Gamified assessments, NLP |

| | | | | |
|---|---|---|---|---|
| 48 | recruitment Smart | Seed round | 13 | machine learning algorithms, NLP |

Table (8): List of companies with fundraising status, number of employees and technology used

Below is a mapping for the startup ecosystem in "Education for Employment" classified based on their AI technology.

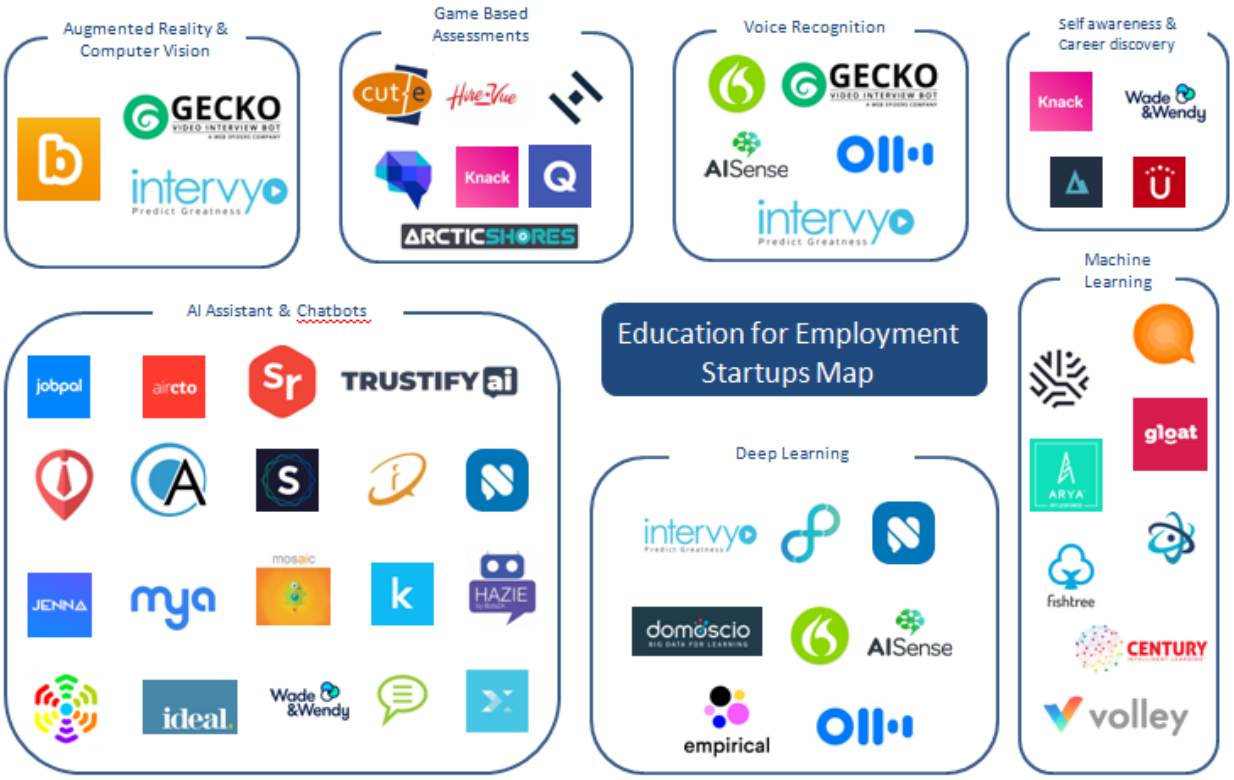



Figure (24): Education for Employment – Startups Map

Companies were classified into three sections, according to the problems that they are tackling; (1) Self awareness and career discovery, (2) acquiring skills and (3) assessment of qualifications and matchmaking. It was found that 67% of the companies are focused on the matchmaking process and less than 8% provides solution for the lack of self and market awareness of the recent graduates and job seekers.

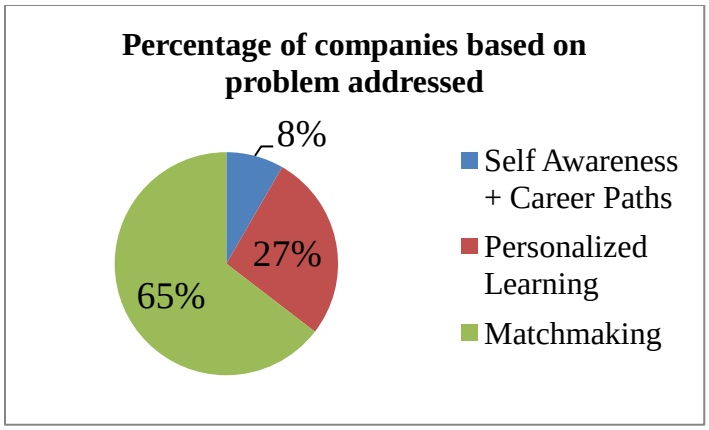



Figure (25): Percentage of companies based on problem addressed

US based startups represented 50% of all startups working within the education for employment sector while United Kingdom came at the 2nd representation with 11% then Israel and Canada with 8% each then Singapore, Germany and India with 2 startups and the least number of startups were from France, Sweden, Egypt, South Africa and Ireland where each had only one startup.


Figure (26): Startups classification based on location and countries

It was also noticed that the US based startups are having a good balance and mix between the sector problems, whereas they represented around 50% (45-62%) of startups within each sub-section followed by UK which was represented by at least 1 startup per category.

| Self Awareness & Career Discovery | | | | Personalized Learning | | | | |
|---|---|---|---|---|---|---|---|---|
| US | UK | Canada | | US | UK | France | Sweden | Ireland |
| 2 | 1 | 1 | | 8 | 2 | 1 | 1 | 1 |
| 50% | 25% | 25% | | 62% | 17% | 8% | 8% | 8% |
| Matchmaking | | | | | | | | |
| US | Israel | Canada | Singapore | Germany | India | UK | Egypt | South Africa |
| 14 | 4 | 3 | 2 | 2 | 2 | 2 | 1 | 1 |
| 45% | 13% | 10% | 6% | 6% | 6% | 6% | 3% | 3% |

Table (9): Startup classification per country per sector category

Another finding was related to the trend of startup launching time. It was found that more than 58% of the startups were established within the last 5 years only. And since 2012, 38 startups out of the 48 was founded which shows how the overall startup ecosystem is growing. Worth mentioning that even the 3 corporates who introduced new AI powered services in related domain was launched also in the past 5 years.

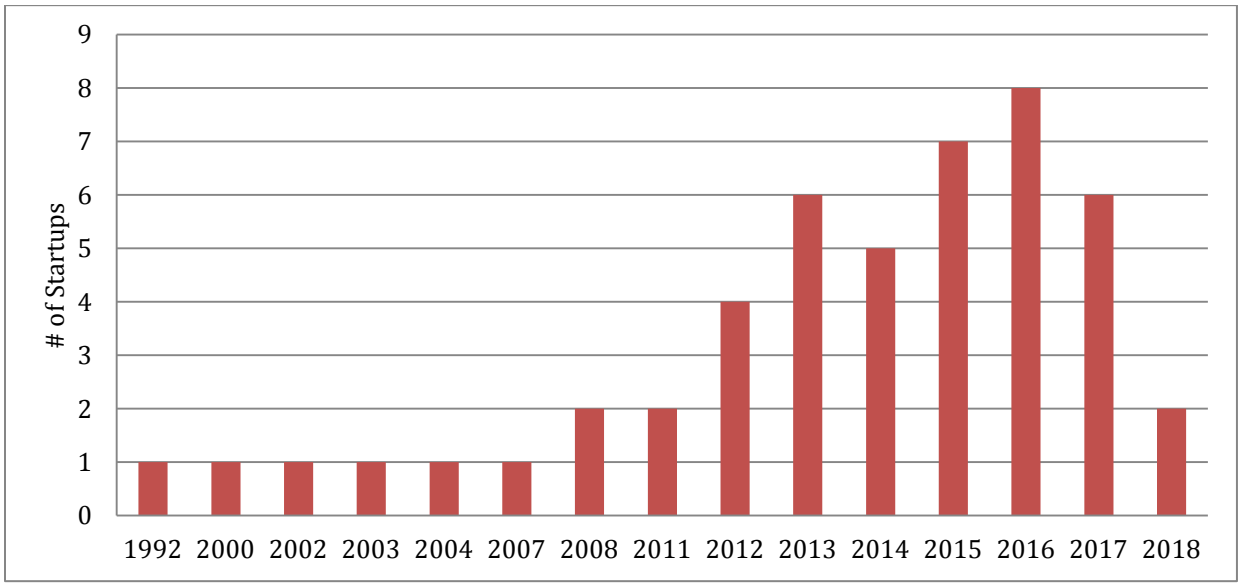



Figure (26): Number of startups launched over years

This growth of such startups not only contributed in solving different education for employment problems but also created jobs within the startups. It was found that 2059 jobs were created out of which 1075 employees were hired in the last 7 years representing more than half the total number of jobs created in the last 26 years within these startups. The average number of jobs

created per startup was found to be 49 new jobs. Those numbers are not reflecting the huge mass of employees who work on Google, LinkedIn or Naunce in their related AI products which was hard to get accurate or even estimated numbers of the team members in such products as it's usually involving cross departmental employees.

The startups growth is also accompanied with increase in fundraising. The total amount of funding announced for 32 startups out of the 48 reached above $814 million. While, within the remaining 16 startups, there were 7 companies received an undisclosed seed rounds. Moreover, 6 different startups were acquired within the last two years. Worth mentioning that LinkedIn acquired Lynda.com in April 2015 in a valuation price worth $1.5 billion in cash and stocks (Kosoff, 2015).

Table (7) shows the list of acquisitions and the raised funds. For LinkedIn the number shown below is the total funds raised before the acquisition. Microsoft acquired LinkedIn at a value worth $26.2 billion (Microsoft buys LinkedIn, 2016).

| Startup | Founded | Raised | Acquisition | Announced date |
|---|---|---|---|---|
| Knewton | 2008 | 182.3 | Acquired by John Willey & Sons | 2019 |
| LinkedIn | 2003 | 154.8 | Acquired by Microsoft | 2016 |
| Fishtree | 2012 | 3 | Acquired by Follett Corporation | 2018 |
| TextRecruit | 2015 | 3 | Acquired by iCIMS | 2018 |
| Blippar | 2011 | 131.7 | Acquired by Candy Capital | 2019 |
| Cut-e | 2002 | Unknown | Acquired by AON PLC | 2017 |

Table (10): List of startups that got acquired last two years

In terms of AI technologies used, it was found that all kinds of known and practical techniques were used within these startups but with understandable variations according to the purpose of the usage. Below is a quick insight about the percentage of technologies used in these startups:

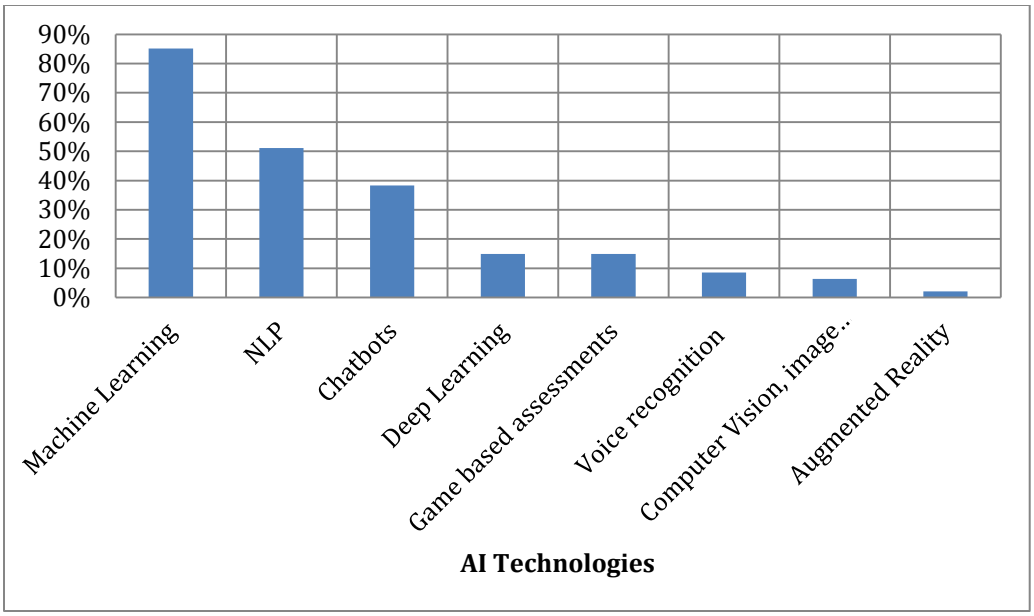



Figure (27): Startups classification based on AI technology

4.5.1 Insights for further discussions:

There are common concerns, challenges and areas of improvements related to the usage of AI powered EFE solutions that might have impact on both the social and economical levels.

1. Digital divide has been a global threat that might lead to inequality, frictions and social divide. Such disparity between those who have access to internet and those who haven't, might be widen by the emergence of AI. With the spread of AI powered learning solutions, the dependency of internet access will increase and thus raising a question about who will benefit the most? In a report published by PWC, AI will lead to 14% increase in global GDP by 2030 with expected higher gains by China and North America which together will receive 70% of such growth, while developing countries will get less than 6% of such benefit (Sizing the prize, 2017).

   The divide might be affected not only by the technology itself but also by the talent shortage. With the presence of major tech hubs in the global north, data scientists and AI professionals at the developing countries find more appealing opportunities abroad leading to brain drain of such talents. The benefits of AI, especially in learning & education, should be distributed equally otherwise such technology will brings new kind of digital divide between those who have AI and those who have not (McSherry, 2018).

Rosenworcel (2016) mentioned that 7 out of 10 teachers assign homework that requires their student to get access to internet while one in three households do not even subscribe to internet service. According to a report published by UNESCO, only 40% of the world's population has internet access with 23.1% penetration in Africa, while Asia and Middle East reached 47% access and Europe has 80.2% access (Leaning, 2017). If those who have no internet connectivity suffer from homework, what would be there challenges with the spread of AI adaptive learning, virtual assistance or other solutions?

2. TVET is an essential part of education and with the evolution of AI and its impact on the job market, it's important to transform the TVET strategies to accommodate such technologies. One of the findings of the study is that non of the startups were clearly addressing TVET in their scope of work. However, technologies such as adaptive learning or virtual assistance or chatbot or even augmented reality can be adapted to the vocational curriculum. Myles Thies, Director of Digital Learning Services at Eiffel Corp, believed that workers will be replaced by AI and automation as the innovation pace is faster than the interventions taken to reskill workers. There is a need to invest in technology and institutions needs to embrace mobility as educators are currently not matching the level of digital teaching and learning (Adapt or die – future proofing TVET colleges for a rapidly changing world, 2018).
3. Lack of self awareness could ruin students and job seekers career (Pozin, 2015). Such major challenge was not enough addressed by the startups. Less than 8% of the startups are focused on such problem and this percentage is very low. 3 out of 4 startups that address such problems are in US & UK where there are already national programs that focus on this problem nationwide such as O*Net and UK National career services. 2 out of the 4 startups are focused on helping students choosing their university and faculty. So there is a clear gap on the career guidance part.
4. There is a huge gap in localization. There is no single adaptive learning platform focused on career or professional development in Middle East, Africa or GCC. One of the good initiatives that was taken by Queen Rania Al-Abdullah - queen consort of Jordan – is the "Education Entrepreneurship Award" by her foundation to recognize potential local innovations in the education business (About the competition, n.d.). Reflecting that on Egypt, there are different solutions that are really needed to be applied with a local

content taking into consideration the cultural and local context. Below are examples of recommended solutions:

a. Delphia model is helping students choosing the best fit school or university through questionnaire that matches recommendations from recent graduates of the same school. In Egypt, more than 10 million are in secondary education (Egypt Education System, 2018). Each year students struggle to chose their college and university taking into consideration the social pressure forced by families and friends. With such AI powered platform, students may find an untraditional reference to enable them to better choose their college and university.
b. Adaptive learning solutions such as Fishtree and Sana Labs can be of use across different universities and schools. But the challenge in implementing such tools is the lack of local digital curriculum.
c. Similar to Blippar solution for AR, AgoRa is an egyptian startup that allow K-12 students to scan everyday objects and learn relevant topics within an augmented reality experience. If such solution incorporate additional AI powered additives, the learning experience might evolve more and more enable more exciting learning experience.
d. Receiving feedbacks and being more engaged in the hiring process are very important things that matter for job applicants. Wuzzuf, the top leading recritment platform in Egypt, recognized that and added (Application Status) feature to allow applicants getting feedback about their apllications whether their application are viewed, shortlisted, or rejected (Why your application is not viewed on WUZZUF, 2017). Chatbots can be of help as well. Chatbots engage the applicants along their hring process thus enable faster and better response.
e. Cut-e model of online gamified assessments is another interesting solution. Adapting such technology in the local market will foster the job matching process. The skill mismatch between what employers are looking for and what graduates really possess is reslting in employer suffering to fill the jobs and graduates suffering from unemployment (Abughattas, 2016). Localizing online gamified assessments will help both the employers and graduates to find the best match.

5. There is no clear integration between different solutions. There is no startup providing end to end career development service using the power of AI. For instance, Knack app provides personal assessment games that enable students to understand their selves and their personal traits and accordingly recommend different careers and on the other side connect with employers to link group of “Knacks” personal traits to jobs. Such solution help students to link self awareness to career explorations, but it miss the learning aspect that will enable the students to actually pursue such careers. Whereas LinkedIn, it enables users to explore different careers, find jobs and recommend learning courses that matches their profile, career history and career aspirations but missing the self awareness and personal assessment part.

6. Finally, questions will remain unanswered at least within the scope of this study regarding; how effective is the recommendations of such AI solutions and how get benefited the most? Will such solutions include algorithmic bias? These questions will need further investigations over time.

# CHAPTER (5): Conclusions and Recommendations

## 5.1 Conclusion:

Human resources are the most precious wealth a country could have and unemployment among youth is considered on top of the challenges that countries face. "Decent jobs" is the 4th sustainable development goal. Insiders and observers can witness how this goal (SDG 8) is a great promoter for the whole 3 components of sustainable development; economic growth, social welfare and environmental sustainability. Different reports and researches indicated that poor education is a major cause for unemployment and definitely unemployment affects on the ability of parents to secure good education for their children which accordingly keep the loop going; poor education today, unemployment tomorrow, lack of education in future.

On the other side, artificial intelligence has been a buzz word that is affecting almost every industry nowadays. Education and employment are not an exception. And It was clear after reviewing literature; on AI, sustainability, AI in education, AI in employment and learning and employability frameworks, that there is no enough research on the applications ad implications of AI on the specific domain of "education for employment" (EFE).

So this study was concerned by understanding the interrelation between education and employment, what frameworks and systems that worked, and how AI can impact the education for employment process whether by introducing new innovations that foster students learning process and placement in the job market or by harming the process and introducing unintentional bias, privacy breach, escalating power consumption and replacing human in workplaces.

In order to answer the above questions, the research was structured in the following way:

1. Review the literature on the origin and technologies of AI to understand how it works and what can these technologies bring
2. Review the literature on sustainability and AI impact on sustainability to understand how technologies can foster or harm the interventions taken towards achieving sustainability
3. Review the literature on AI in education and in employment to understand different solutions that AI can bring in both domains separately

4. Review the literature on different learning and employability frameworks to understand the challenges, dynamics and the wide spectrum of the domain and how connections are built between every intervention with the process

The above review concluded that, beside the mismatch problem between job seekers and employers, there is a huge practical room for AI to facilitate school to university and university to work transitions. The next step was to scout for various innovative solutions using AI that help students, learners and job seekers enhance their employability. The study focused the search on 3 main EFE problems:

1. Problem 1: Lack of self Awareness which affects the career choice
2. Problem 2: Lack of required skills by the job market that ensure career readiness
3. Problem 3: Lack of qualification assessments which affects the job hunting process

The study mapped out 48 companies/startups working in the EFE "Education for Employment" domain. Below are the classifications of the companies according to their main scope of work:

1. Self Awareness + Career Paths: 4 companies
2. Learning and skills building:13 companies
3. Qualification assessment and matchmaking: 31 companies

Within the above 3 main pillars, there was found 12 different innovative solutions that AI brought to the EFE process. Below is a list of these interventions with respect to the related pillar:

1. Self Awareness + Career Paths:
    - AI experimental solution for eye tracking and scanning that can assess personality
    - AI games that let people express and indentify their knacks (traits and abilities)
    - AI powered Chatbots that advise people about their career path and exploration options and resources

2. Learning and skills building:
    - AI educational solutions that adapt and personalize the learning experience
    - AI powered augmented reality solution that build interactive visual material

- AI virtual learning assistant
- Speech to text AI learning solutions

3. Qualification assessment and matchmaking:
    - AI virtual assistants for profile building, resume review and ATS compatibility
    - AI powered neuroscience games to match candidates to the best fit jobs
    - AI search engines that sort and categorize jobs from a wide range of job sites
    - AI chatbots for job recommendations
    - AI matchmaking platforms that use different forms of personal and qualification assessments

By the end of this mapping, insights and analysis was conducted and below are the main findings:

1. 52% of the innovations presented in the EFE domain were brought by US based companies followed by Israel, Canada, and United Kingdom that brought 25% collectively. While Europe based started contributed by 11% followed by China and India that contributed by 8% combined. And finally Africa – presented by Egypt and South Africa – contributed by 4%.
2. The United States and United Kingdom are the only countries that have a healthy mix of companies that are covering the 3 main pillars (Self Awareness + Career Paths, Learning + skills building, and Qualification assessment + matchmaking). This raise a question and a concern on the available local tools and resources in front of learners and job seekers in different countries and how governments, educational institutions and employers will address the EFE challenges with the dynamics of job market and how students are being prepared for the future of work.
3. While self awareness is recognized as the initial step in students' career exploration and readiness and it could ruin their career with uninformed decisions, there was a clear gap in attention towards this problem. Only 4 startups globally were found to address such problem. Which raises a flag for the role of universities, and educational institutes to address this challenge differently.

4. The past 7 years witnessed growth rates in founding startups or entrepreneurial endeavors that contributed to not only solving education for employment problems but also creating jobs and enhance the value chain. It was found that 2059 jobs were created out of which 1075 employees were hired in the last 7 years representing more than half the total number of jobs created in the last 26 years within these startups. And the average number of jobs created per startup was found to be 49 new jobs. The startups growth was accompanied by strong fundraising activities reaching total investments worth $814 million in addition to 6 acquisitions. LinkedIn alone had acquired Lynda.com with total value of $1.5 billion to enrich LinkedIn users' experience by (LinkedIn Learning).
5. From a social prospective, AI had brought solutions and benefits to the process that might not been accessible before. Below are examples of benefits that were recognized:
    a. AI enabled startups to create more jobs and help individuals understand themselves, choose their career and find a good career match.
    b. Reduced bias in the recruitment process while in universities or with employers. One of the AI tools is the personality assessment games which involve candidates in an immersive experience and doesn't measure the results based on score or versus peers, but it only identify the personal traits to get the best match disregarding gender or any backgrounds.
    c. Provided access for learning opportunities to students in remote areas or in villages with single sex schools who are isolated from good education. With virtual teaching solutions powered by AI, students can have access to better education in addition to broadening curricula which is another problem related to the rigid curriculums found in some regions specially in middle east.
    d. Provided access to students with different learning styles. AI enabled more engagement, personalization and assistance through chatbot, Augmented reality and adaptive learning solutions.
    e. Provided access to students or learners with some disabilities through speech or voice recognition and speech to text solutions which enabled them to overcome lots of communication challenges.

f. Helped young pupils and their parents to effectively choose their education field and universities removing the annoying hassle of selection and reduced the risk of changing majors or faculties or even careers in the future.
g. Enabled teachers to get better insights about their students, who have different learning capabilities and pace. This enriched the learning experience through better learning analytics. Also removed the inefficient administrative work from the teachers' shoulders allowing them to dedicate their quality of time in more engaging activities with the students.

However, there are concerns that should be addressed while using AI that might affect the social aspect:

a. AI cause unintentional social bias through integrating human bias in the training data set which create systematic bias. As illustrated, AI is influenced by the training data set extensively. So the concept or "garbage in, garbage out" is amplified in AI. For instance, if an AI recruitment system try to identify candidates with attributes similar to top performers within an organization. If these top performers all have similar backgrounds, then the organization will continue to hire within the same narrow talent profile.
b. Eliminating some jobs or replacing human in other types of jobs which could add social pressure on the community and add more pressure on educational institutions to build different curriculum enabling workers and job seekers to be ready for the future of work. Also adding more challenges for governments to revise their TVET programs and educational frameworks to address the change in the job market dynamics.
c. AI may raise a large concern related to personal data privacy. Accessing personal information to enhance the activation of AI tools might raise concern by users regarding their data privacy. For instance, matching platforms have access to personal career history, preferences, personality traits and interests. Such data might be misused if there have been any security breach of such data or misused by the companies itself.
d. AI might indirectly increase the witnessed social isolation between family members and friend groups and the dependency on technology. People tend to communicate

silently through typing on their phones or viewing others profiles. According to Gartner report, by 2020 people will communicate more with their digital assistants/chatbots than their spouse (Levy, 2016).

e. Another ethical concern was raised related to chatbot, as users don't always know if they are chatting with human or a bot which impose an ethical question regarding giving a false impression to customers who assume they are interacting with human
f. Finally, there is a concern regarding social deprivation. Usually games or the different AI learning solutions are accessed online and remotely, so candidates who can't have access to internet connection can be disengaged from the new learning or hiring processes. Digital divide might increase with the emergence of AI usage in EFE and a new kind of digital divide might rise between those who have AI and those who have not.

6. From an economic prospective, AI brought benefits such as:
    a. Helped employers find better matching candidates in almost half the traditional time, increased the engagement process in the hiring process and increased the retention rates. Chatbots have enhanced the candidate experience which is one of the reasons 74% of candidates drop from the application process. Such a percentage is impacting the employment industry which generated €491 billion of sales revenue worldwide in 2017. Additionally, it frees up valuable time for the hiring managers to better utilize it in a more valuable tasks.
    b. Labor automation, innovation, and new competition, affect AI-driven productivity growth. The study showed how 94% of innovation in the EFE domain were introduced by startups which foster positive competition and also the huge investment in such startups enabled job creation and enabled new business opportunities.
    c. Better productivity is generally achieved by automation capabilities that enabled by AI.

However, there is also concern that should be addressed while using AI that might affect the economic aspect which is the nefarious act for hacking of personal private data. Secuirty became more risky as data are being more available and analytics provide insightful data on personal, industrial and country level. Cybersecurity became more important on national levels as any kind of Cybersecurity breach would lead to massive costs.

7. From an environmental prospective, AI , in general, have various implications:
    a. Empirical evidence was introduced by Andrew Meyer - Assistant Professor, Department of Economics, Marquette University - to support the hypotheses that unemployment is not good for environmental initiatives as such initiatives require monetary contributions, and might be good as these initiatives require time and effort that is available for unemployed individuals (Meyer, 2016).
    b. Reduce paper waste. According to the Environmental Protection Agency Fact Sheet 2014, the United States generated 68.6 million tons of paper and paperboard waste (Advancing SustainableMaterials Management: 2014 Fact Sheet, 2016).AI has promoted the use of online adaptive learning and online sharing for books and resources which cut off paper use extensively.
    c. However, AI may increase energy consumption and electronic wastes, as companies are shifting to more heavy computational powers to adopt their AI training and analytics, this will require more energy and will dispatch tons of existing computers and related electronic devices.

**5.2 Recommendations:**

At the end, this study is meant to be an eye opener for how AI can impact our efforts in education for employment. Based on what has been highlighted within the study, below are some recommendations for startups, universities and employers.

For startups:

- There is a great need for more AI game based solutions to address the problem of lack of self and market awareness among young people. Whether creating simulations, or games or gamified personality assessment, such solutions should be combined with deeper market understanding of what could be a good career or job match for the individual assessment's results.
- Localization within countries or regions is mandatory and missing. Within the study period of research, it was not found any single AI powered career development or skill building solution in Middle East or Africa or Gulf area.

- Augmented reality has great outcomes in the learning process and despite that there is only one AR startup that utilizes AI technologies to serve in the area of professional and skill development.

For Universities:

- Career development is an integral part and should be integrated within the academic curriculum or calendar. Dedicated staff should be providing career services the school and university such as career counseling, professional development workshops and guidance in the hiring process.
- Adopting data driven solutions, can alert the students' supervisors with any progress issues for the student and accordingly actions can be taken at the right time.
- Engaging the industry and employers can uplift the curriculum and create a network of professionals who can support students in their career and future choices.

For Employers:

- Engaging early enough with schools and universities with either campus activities or even online interventions will help in building the right skills, knowledge and attitude that recruiters suffer from finding at later stages after graduation.
- Adopting AI solutions in the hiring process or even in employer branding activities can engage, attract, and enlighten youth which again reflects on decreasing the time lost in long hiring processes and reduce hiring budgets.

For governments:

- Referring to the concept of "garbage in, garbage out" in training the data set for machine learning, governments should set regulations to navigate the risks associated to such systematic bias and dedicate public resources for the creation and aggregation of accurate and Bias-Free data sets.
- Leading constructive dialogue to take to ensure the development of AI with a net positive impact on society.

# Bibliography

*A new, outcomes-based solution is needed to finance higher education*. (n.d.). Retrieved from Income Share Agreements: https://incomeshareagreements.org/

*About Aquinas Learning*. (n.d.). Retrieved from Welcome.AI: https://www.welcome.ai/aquinas-learning

*About BridgeU*. (n.d.). Retrieved from BridgeU: https://bridge-u.com/about/

*About Glassdoor*. (n.d.). Retrieved from Glassdoor: https://www.glassdoor.com/about-us/

*About Indeed*. (n.d.). Retrieved from Indeed: https://www.indeed.com/about

*About Jobzmall*. (n.d.). Retrieved from Jobzmall: https://about.jobzmall.com/

*About LinkedIn*. (n.d.). Retrieved from LinkedIn: https://about.linkedin.com/

*About Sana Labs*. (n.d.). Retrieved from Sana Labs: https://sanalabs.com

Andersen, P. (2006). The Career Diamond: A Teaching Tool Illustrating The Process Of Career Counseling. *The American Counseling Association* , 1-12.

Andrews, W. (2018). *Craft an Artificial Intelligence Strategy: A Gartner Trend Insight Report.* Gartner, Inc.

(2017). *Annual Report* . Pratham Education Foundation.

*Artificial Intelligence*. (n.d.). Retrieved April 29, 2019, from English Oxford Living Dictionaries: https://en.oxforddictionaries.com/definition/artificial_intelligence

*Artificial Intelligence*. (n.d.). Retrieved April 29, 2019, from Mac Millan Dictionary: https://www.macmillandictionary.com/dictionary/british/artificial-intelligence

*AUC Cocurricular Transcript*. (n.d.). Retrieved from American University in Cairo: https://www.aucegypt.edu/students/co-curricular-transcript

Autor, D., Levy, F., & Murnane, R. (2003). The Skill Content Of Recent Technological Change: An Empirical Exploration. *MIT Quarterly Journal of Economics* .

*Background of the sustainable development goal*. (n.d.). Retrieved 2019, from UNDP: https://www.undp.org/content/undp/en/home/sustainable-development-goals/background.html

Bandura, A. (1971). *Social Learning Theory.* New York: General Learning Press.

Bayne, S. (2015). Teacherbot: interventions in automated teaching. *Teaching in Higher Education* , 455-467.

Becker, G. S. (1962). Investment in Human Capital: A Theoretical Analysis. *Journal of Political Economy* , 9-49.

Bilotta, F. F., Werner, S. M., Bergese, S. D., & Rosa, G. (2013). Impact and Implementation of Simulation-Based Training for Safety. *The Scientific World Journal* , Bilotta, F. F., Werner, S. M., Bergese, S. D., & Rosa, G. (2013). Impact and 652956. doi:10.1155/2013/652956.

Boyer, R. H., Peterson, N. D., Arora, P., & Caldwell, K. (2016). Five Approaches to Social Sustainability and an Integrated Way Forward. *Sustainability, 8(9), MDPI AG* .

Brunello, G., & Rocco, L. (2017). The effects of vocational education on adult skills, employment and wages: What can we learn from PIAAC? *Springer Link* , 8 - 315.

Butcher, M. (2017). *bridgeu raises $5.3 m to close the gap between education and industry needs*. Retrieved from techcrunch: https://techcrunch.com/2017/10/17/bridgeu-raises-5-3m-to-close-the-gap-between-education-and-industry-needs/

*Can I use DiSC for hiring or recruitment?* (n.d.). Retrieved from DiSC Profile: https://www.discprofile.com/which-disc-to-use/disc-for-hiring/

Carl Frey, M. O. (2013, September 17). *THE FUTURE OF EMPLOYMENT*. Retrieved April 29, 2019, from Oxford Martin: https://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

Cellan-Jones, R. (2016, October 20). *Stephen Hawking - will AI kill or save humankind?* Retrieved from BBC: https://www.bbc.com/news/av/technology-37713942/stephen-hawking-warns-of-dangerous-ai

Cellan-Jones, R. (2014, December 2). *Stephen Hawking warns artificial intelligence could end mankind*. Retrieved April 30, 2019, from BBC: https://www.bbc.com/news/technology-30290540

Chamorro-Premuzic, T. (2016, January 04). *Strengths-Based Coaching Can Actually Weaken You*. Retrieved from Harvard Business Review: https://hbr.org/2016/01/strengths-based-coaching-can-actually-weaken-you

*Clifton Strengths*. (n.d.). Retrieved from Gallup Strength Center: www.gallupstrengthscenter.com

*Clifton StrengthsFinde Resource Guide.* (n.d.). Retrieved from ONONDAGA COMMUNITY COLLEGE: http://students.sunyocc.edu/uploadedFiles/_Shared_Content/Departments_and_Offices/Other_Groups/StrengthsQuest/Mgmt%20ResourceGuide.pdf

*Cognii Virtual Learning Assistant*. (n.d.). Retrieved from Cognii: http://www.cognii.com/products#vla

Cohn, S. (2019, February 8). *Purdue University has come up with a new way to pay for college*. Retrieved from CNBC: https://www.cnbc.com/2019/02/08/purdue-university-introduces-first-income-sharing-agreement-for-students-.html

Delgado, A. (2018, June 13). *Three Impacts Of Artificial Intelligence On Society*. Retrieved Jan 2019, from Forbes: https://www.forbes.com/sites/forbestechcouncil/2018/06/13/three-impacts-of-artificial-intelligence-on-society/#37755b126ec0

Diesendorf, M. (1999). Sustainability and Sustainable Development. In B. J. D, *Sustainability: The corporate challenge* (pp. 19-37). Sydeny: Allen & Unwin.

Dittrich, T., & Star, S. (2018). Introducing Voice Recognition into Higher Education. *4th International Conference on Higher Education Advances (HEAd'18)* (pp. 759-767). Valencia: Universitat Politecnica de Valencia.

*Dragon Speech Recognition for education*. (n.d.). Retrieved from Naunce: https://www.nuance.com/dragon/industry/education-solutions.html

Eadicicco, L. (2015, January 28). *Bill Gates: Elon Musk Is Right, We Should All Be Scared Of Artificial Intelligence Wiping Out Humanity*. Retrieved April 30, 2019, from Business Insider: https://www.businessinsider.com/bill-gates-artificial-intelligence-2015-1

Elliot, S., & D, B. (2008). Environmentally sustainable ICT: developing corporate capabilities and an industry-relevant is research agenda. *the Pacific Asia Conference on Information Systems (PACIS)*, (p. 209). Suzhou.

*EMEA Winners*. (2016). Retrieved from Talent Unleashed Awards: https://www.talentunleashedawards.com/winners/2016-uk-winners/

Erek, K., Schmidt, N.-H., Zarnekow, R., & Kolbe, L. (2009). Sustainability in information systems: assortment of current practices in IS organizations. *the Americas Conference on Information Systems (AMCIS)*, (p. 123). San Francisco.

Essig, T. (2014, September 29). *The Mysterious Popularity Of The Meaningless Myers-Briggs (MBTI)*. Retrieved from Forbes: https://www.forbes.com/sites/toddessig/2014/09/29/the-mysterious-popularity-of-the-meaningless-myers-briggs-mbti/#5d3d03341c79

Faggella, D. (2019, April 24). *Examples of Artificial Intelligence in Education*. Retrieved 2019, from Emerj: https://emerj.com/ai-sector-overviews/examples-of-artificial-intelligence-in-education/

*Fishtree product review*. (n.d.). Retrieved from EdSurge: https://www.edsurge.com/product-reviews/fishtree

Flanagan, J. (2014, March 6). *Tinder-style matchmaking helps you bag your next job*. Retrieved from New Scientists: https://www.newscientist.com/article/dn25172-tinder-style-matchmaking-helps-you-bag-your-next-job/

Ford, M. (2013). Could Artificial Intelligence Create an Unemployment Crisis? *Communications of the ACM* .

Frinault, Y. (2018, July 17). *How to Attract Millenials & Gen Z to Blue-Collar Jobs*. Retrieved from Glassdoor: https://www.glassdoor.com/employers/blog/millenials-blue-collar-jobs/

*From MDGs to SDGs*. (n.d.). Retrieved Jan 2019, from Sustainable Development Goals Fund: http://www.sdgfund.org/mdgs-sdgs

Gardner, W. L., & Martinko, M. J. (1996). Using the Myers-Briggs Type lndicator to Study Managers. *Journal of Management* , 45–83.

Giang, V. (2012, April 4). *What Recruiters Look At During The 6 Seconds They Spend On Your Resume*. Retrieved from Business Insider: https://www.businessinsider.com/heres-what-recruiters-look-at-during-the-6-seconds-they-spend-on-your-resume-2012-4

Gibson, D., Ostashewski, N., Flintoff, K., Grant, S., & Knight, E. (2013). Digital badges in education. *Springer* , 403–410.

Gibson, R. B. (2006). BEYOND THE PILLARS: SUSTAINABILITY ASSESSMENT AS A FRAMEWORK FOR EFFECTIVE INTEGRATION OF SOCIAL, ECONOMIC AND ECOLOGICAL CONSIDERATIONS IN SIGNIFICANT DECISION-MAKING. *Journal of Environmental Assessment Policy and Management* , 259-280.

*Global Mobile Awards* . (2017, March 3). Retrieved from Blippar Blog: https://www.blippar.com/blog/2017/03/03/blippar-wins-best-app-vrar-gsmas-global-mobile-awards-2017

Gottlieb, H., & Backlund, M. (2015). *The Knowledge Traingle Programme: Methods and Tools in Design, Culture, Smart Cities, Health, Welfare and Entrepreneurship.* Copenhagen: Nordic Council of Ministers.

*Guidelines for Hiring an Outside Consultant*. (n.d.). Retrieved from Myers Briggs Foundation: https://www.myersbriggs.org/my-mbti-personality-type/hiring-an-mbti-consultant/guidelines-for-hiring-an-outside-consultant.htm

Hamza-Lup, F. G. (2018). *A Distributed Augmented Reality System for Medical Training and Simulation.* Orlando: University of Central Florida - School of Computer Science.

Hansen, L. (1976). Career Development Education: Humanizing Focus for Educators. *Journal of Career Development* , 42-48.

Haugeland, J. (1985). *Artificial Intelligence: The Very Idea.* MIT Press.

Hawksworth, J. (2018, September 18). *AI and robots could create as many jobs as they displace*. Retrieved 2019, from World Economic Forum: https://www.weforum.org/agenda/2018/09/ai-and-robots-could-create-as-many-jobs-as-they-displace/

Hawksworth, J., Berriman, R., & Goel, S. (2018, Feb). *How will automation impact jobs?* Retrieved 2019, from Pricewatercoopers: https://www.pwc.co.uk/economic-services/assets/international-impact-of-automation-feb-2018.pdf

Hayes, L. N. (2018, August 9). *More Than Half of Employers Have Found Content on Social Media That Caused Them NOT to Hire a Candidate, According to Recent CareerBuilder Survey*. Retrieved from Careerbuilder: http://press.careerbuilder.com/2018-08-09-More-Than-Half-of-Employers-Have-Found-Content-on-Social-Media-That-Caused-Them-NOT-to-Hire-a-Candidate-According-to-Recent-CareerBuilder-Survey

Heath, N. (2018, February 12). *What is AI? Everything you need to know about Artificial Intelligence*. Retrieved from Zdnet: https://www.zdnet.com/article/what-is-ai-everything-you-need-to-know-about-artificial-intelligence/

Herweijer, C. (2018, January 24). *8 ways AI can help save the planet*. Retrieved January 2019, from World Economic Forum: https://www.weforum.org/agenda/2018/01/8-ways-ai-can-help-save-the-planet/

*History of DiSC*. (n.d.). Retrieved from DiSC Profile: https://www.discprofile.com/what-is-disc/history-of-disc/

Hoppe, S., Loetscher, T., Morey, S. A., & Bulling, A. (2018). Eye Movements During Everyday Behavior Predict Personality Traits. *Frontiers in Human Neuroscience* , 12:105. doi: 10.3389/fnhum.2018.00105.

Hosie, R. (2017, August 11). *WHY THE MYERS-BRIGGS TEST SHOULD NEVER BE USED IN RECRUITMENT*. Retrieved from Independent: https://www.independent.co.uk/life-style/myers-briggs-test-recruitment-why-never-use-occupation-psychologists-a7888076.html

Jayden Khakurel, B. P. (2018). The Rise of Artificial Intelligence under the Lens of Sustainability. *Technologies* , 6(4), 100.

Khakurel, J., Penzenstadler, B., Porras, J., Knutas, A., & Zhang, W. (2018). The Rise of Artificial Intelligence under the Lens of Sustainability. *Technologies* , 6(4), 100.

Kietzmann, J., Paschen, J., & Treen, E. R. (2018). Artificial Intelligence in Advertising: How Marketers Can Leverage Artificial Intelligence Along the Consumer Journey. *Journal of Advertising Research* , 263-267.

*Knack FAQ*. (n.d.). Retrieved from Knackapp: https://www.knackapp.com/faq/

Knowdell, R. L. (1977). *Knowdel Career Values Worksheet.* Retrieved from Career Network: https://www.careernetwork.org/WorkSheets/Values%20Work%20Sheet%20Jan%20'11.pdf

Kolb, A. Y. (2013). *THE KOLB LEARNING STYLE INVENTORY- Version 4.0.* Retrieved from Learning from Experience: https://learningfromexperience.com/downloads/research-library/the-kolb-learning-style-inventory-4-0.pdf

Kurzweil, R. (1990). *The Age of Intelligent Machines.* MIT Press.

*Lambda School FAQ*. (n.d.). Retrieved from Lambda School: https://lambdaschool.com/faq/

Loeffler, J. (2018, December 24). *Personalized Learning: Artificial Intelligence and Education in the Future*. Retrieved February 23, 2019, from Interesting Engineering: https://interestingengineering.com/personalized-learning-artificial-intelligence-and-education-in-the-future

Loveder, P. (2017). *Loveder, P. (2017). Australian Apprenticeships: trends, challenges and future opportunities for dealing with Industry 4.0.* Adelaide: National Centre for Vocational Education Research.

Luger, G. F. (1993). *Artificial Intelligence, Structures and Strategies for Complex Problem Solving.* Pearson Education India .

Maderer, J. (2016, May 9). *Artificial Intelligence Course Creates AI Teaching Assistant*. Retrieved March 23, 2019, from Georgia Tech News center : https://www.news.gatech.edu/2016/05/09/artificial-intelligence-course-creates-ai-teaching-assistant

Marston, W. M. (1928). *Emotions of normal people.* London: K. Paul, Trench, Trubner & Co. Ltd.

Martens, B., & Tolan, S. (2018). *Will this time be different? A review of the literature on the Impact of Artificial Intelligence on Employment, Incomes and Growth.* Digital Economy Working Paper 2018-08; JRC Technical Reports.

Martin, G. (2018). *The meaning and origin of the expression: Artificial intelligence*. Retrieved from www.phrases.org.uk: https://www.phrases.org.uk/meanings/artificial-intelligence.html

Masayuki, M. (2016). The Effects of Artificial Intelligence and Robotics on Business and Employment: Evidence from a survey on Japanese firms. *RIETI Discussion Papers Series* .

Matthews, K. (2017, June 22). *5 chatbots that will help you find a job*. Retrieved from Venture Beat: https://venturebeat.com/2017/06/22/5-chatbots-that-will-help-you-find-a-job/

*MBTI Basics*. (n.d.). Retrieved from The Myers Briggs Foundation: https://www.myersbriggs.org/my-mbti-personality-type/mbti-basics/isabel-briggs-myers.htm?bhcp=1

McCorduck, P. (2004). *Machines Who Think.* New York: A K Peters, Ltd.

McCulloch, W., & Pitts, W. (1943). *A LOGICAL CALCULUS OF THE IDEAS IMMANENT IN NERVOUS ACTIVITY*. Chicago.

Mckay, D. R. (2018, August 20). *The Strong Interest Inventory; You Need to Know About This Career Assessment*. Retrieved from The Balance Careers: https://www.thebalancecareers.com/the-strong-interest-inventory-526173

McKendrick, J. (2018, December 4). *Now, AI Makes Online Courses Even Smarter*. Retrieved from Forbes: https://www.forbes.com/sites/joemckendrick/2018/12/04/now-ai-makes-online-courses-even-smarter/#4cc5497710b1

McKinsey & Company. (2014). *Disrupting Unemployment; Automotive Manufacturing Technical Education Collaborative (AMTEC).* World Economic Forum.

McLeod, S. (2017, October 24). *Kolb's Learning Styles and Experiential Learning Cycle*. Retrieved from Simply Phsycology: https://www.simplypsychology.org/learning-kolb.html

Mejia, T. (2018, December 18). *AI Meets AR*. Retrieved from Adobe Blog: https://theblog.adobe.com/ai-meets-ar/

*Millennium Development Goals (MDGs)*. (n.d.). Retrieved 2019, from World Health Organization: https://www.who.int/topics/millennium_development_goals/about/en/

Moore, E. (2019, March 15). *Your CV Has 7 Seconds to Get a Recruiter's Attention — Here's How to Make It Count*. Retrieved from Glassdoor: https://www.glassdoor.co.uk/blog/7-second-cv/

Moskal, P., Carter, D., & Johnson, D. (2017). *7 Things You Should Know About Adaptive Learning.* EDUCAUSE Learning Initiative.

Mourshed, M., Farrell, D., & Barton, D. (n.d.). *Education to employment: Designing a system that works.* Retrieved April 1, 2019, from McKinsey Center for Government:

https://www.mckinsey.com/industries/social-sector/our-insights/education-to-employment-designing-a-system-that-works

Mourshed, M., Farrell, D., & Barton, D. (2013). *Education to employment: Designing a system that works.* Retrieved April 1, 2019, from McKinsey Center for Government: https://www.mckinsey.com/industries/social-sector/our-insights/education-to-employment-designing-a-system-that-works

Naik, D. (20118, March 18). *Augmented Reality—with React-Native*. Retrieved from AR VR Hourney: https://arvrjourney.com/augmented-reality-with-react-native-15219f36e3f2

*National Careers Service*. (n.d.). Retrieved May 1, 2019, from https://nationalcareersservice.direct.gov.uk/

*National Center for O*NET Development*. (n.d.). Retrieved January 23, 2019, from O*NET OnLine: https://www.onetonline.org/

Nauta, M. M. (2010). The Development, Evolution, and Status of Holland's Theory of Vocational Personalities: Reflections and Future Directions for Counseling Psychology. *Journal of Counseling Psychology* , 11–22.

Nazerian, T., & Wan, T. (2018, March 20). *The 8 Education Technology Startups From Y Combinator's Latest Batch*. Retrieved from EdSurge: https://www.edsurge.com/news/2018-03-20-y-combinator-s-newest-batch-of-education-technology-startups

*Newton Home page*. (n.d.). Retrieved from Newton.ai: https://newton.ai/

Nicholas Chen, L. C. (2016). *Global Economic Impacts Associated with Artificial Intelligence.* Analysis Group.

Nilsson, N. (1984). Artificial Intelligence, Employment and Income. *The AI Magazine* .

Nilsson, N. J. (1998). *Artificial intelligence: a new synthesis.* Elsevier.

Nilsson, N. J. (1984). Artificial Intelligence, Employment and Income. *The AI Magazine* .

Nilsson, N. J. (2010). *The quest for artificial intelligence: A history of ideas and achievements.* Cambridge University Press.

Norvig, P., & Russell, S. (2010). *Artificial Intelligence; A Modern Approach.* Pearson Education.

Novoresume. (n.d.). *Novoresume Home page*. Retrieved from Novoresume: https://novoresume.com/?noRedirect=true

*Nursing Skills Centre of Excellence*. (n.d.). Retrieved from Box Hill Institute: https://www.boxhill.edu.au/partnerships/centres-of-excellence/nursing-skills-centre-of-excellence-simulation-centre/training/

Poole, D., Mackworth, A., & Goebel, R. (1998). *Computational Intelligence A Logical Approach.* New York: Oxford University Press.

Popenici, S., & Kerr, S. (2017). *Exploring the impact of artificial intelligence on teaching and learning in higher education.* Springer Open.

Popenici, S., & Kerr, S. (2017, November 23). Exploring the impact of artificial intelligence on teaching and learning inhigher education. *Research and Practice in Technology Enhanced Learning* .

Powers, K. (2018, October 24). *Why Certifications are Important*. Retrieved from Ed4Career: https://ed4career.com/blog/why-certifications-are-important

*Pratham Institute Approach*. (n.d.). Retrieved from Pratham Institute for Literacy, Education & Vocational Training: http://prathaminstitute.org/Approach1.aspx

*Pratham Unique Model*. (n.d.). Retrieved from Pratham Hotels: http://www.prathamhotels.com/uniqe-model.html

(2012). *Progress on Drinking Water and Sanitation* . World Health Organization; UNICEF.

*Project Management Professional*. (n.d.). Retrieved from Project Management Institute: https://www.pmi.org/certifications/types/project-management-pmp

Pymetrics. (n.d.). *HIRING BASED IN NEUROSCIENCE + DATA SCIENCE*. Retrieved from Pymetrics: https://www.pymetrics.com/science/

*Queen's major Maps*. (n.d.). Retrieved from Queen's University Career Services : https://careers.queensu.ca/students/wondering-about-career-options/major-maps

Rayman, J. R. (2008, 11 27). *A Tribute to John L. Holland: Psychologist, Theoretician, Scholar, Researcher, Counselor, and Friend*. Retrieved from National Career Development Association: https://associationdatabase.com/aws/NCDA/pt/sd/news_article/6521/_PARENT/layout_details/false

Reaney, P. (2015, November 19). *Matchmaking seen as potential game changer in online job search market*. Retrieved from Reuters: https://www.reuters.com/article/us-usa-employment-internet/matchmaking-seen-as-potential-game-changer-in-online-job-search-market-idUSKCN0T82JN20151119

Riffle, C. (2017, July 19). *What artificial intelligence means for sustainability*. Retrieved from greenbiz: https://www.greenbiz.com/article/what-artificial-intelligence-means-sustainability

Rigano, C. (2019). Using Artificial Intelligence to Address Criminal Justice Needs. *National Institute of Justice* .

Riley, T. (2018, August 2). *Google's newest push to radically improve the online job hunt for millions of Americans*. Retrieved from CNBC: https://www.cnbc.com/2018/08/01/google-job-search-is-using-ai-to-make-job-searching-a-whole-lot-easier.html

Roger Schank, S. S. (1985). *Education and Computers: An AI Prospective.* Yale Department of Computer Science.

Ross, A. (2019, jauary 9). *No Tuition, but You Pay a Percentage of Your Income (if You Find a Job)*. Retrieved from The New York Times: https://www.nytimes.com/2019/01/08/business/dealbook/education-student-loans-lambda-schools.html

Rossheim, J. (2017). *Minimize Costs by Reducing Time to Hire*. Retrieved from Monster: https://hiring.monster.com/employer-resources/recruiting-strategies/compensation/reducing-time-to-hire-checklist/

Say, J. B. (1828). *Cours complet d'économie politique pratique.* Paris: Chez Rapilly.

Schmidt, A. (2017, December 27). *How AI Impacts Education*. Retrieved February 2019, from Forbes: https://www.forbes.com/sites/theyec/2017/12/27/how-ai-impacts-education/#22edd83f792e

Schultz, T. W. (1961). Investment in Human Capital. *The American Economic Review* , 1-17.

Schwab, K. (2016, January 14). *The Fourth Industrial Revolution: what it means, how to respond*. Retrieved April 1, 2019, from World Economic Forum: https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/

Sharma, T. (2018, April 20). *HOW AUGMENTED REALITY IN THE WORKPLACE CAN ENHANCE TRAINING*. Retrieved from Blippar Blog: https://www.blippar.com/blog/2018/04/20/how-augmented-reality-workplace-can-enhance-training

Shenoy, S. (2019). *108 Must-Know Project Management Statistics for You to Gain Unfair Advantage this Year*. Retrieved from PM Exam Smartnotes: https://www.pmexamsmartnotes.com/108-project-management-statistics/

Shetelboim, R., & Hsu, W. (2018). *2018 Recruiting Benchmark Report.* Jobvite.

Silva, L. (2018, January 24). *How can technology drive sustainability?* Retrieved April 10, 2019, from Cognifide: https://www.cognifide.com/our-blogs/marketing-technology/how-can-technology-drive-sustainability

SINGH, P., & FINN, D. (2003). The Effects of Information Technology on Recruitment. *JOURNAL OF LABOR RESEARCH* .

*Squirrel AI Story*. (n.d.). Retrieved from Squirrel AI: http://squirrelai.com/our-story

Stolzoff, S. (2018, August 19). *Schools are using AI to track what students write on their computers*. Retrieved May 2019, from Quartz: https://qz.com/1318758/schools-are-using-ai-to-track-what-students-write-on-their-computers/

Strelkova, O., & Pasichnyk, O. (2017). *THREE TYPES OF ARTIFICIAL INTELLIGENCE.* Khmelnitsky National University.

Susi, T., Johannesson, M., & Backlund, P. (2007). *Serious Games – An Overview.* Skövde : University of Skövde - School of Humanities and Informatics.

Tegmark, M. (2017). *Life 3.0: Being Human in the Age of Artificial Intelligence.* Knopf.

(2018). *The Future of Jobs* . Centre for the New Economy and Society.

*The initiative: El Sewedy Technical Academy*. (n.d.). Retrieved from El Sewedy Technical Academy: https://sta.edu.eg/about-sta/about-us/

(2015). *The Millennium Development Goals Report.* United Nations.

*The National Career Readiness Certificate*. (n.d.). Retrieved from ACT: https://www.act.org/content/act/en/products-and-services/workkeys-for-workforce-developers/ncrc.html

Tremblay, K., Lalancette, D., & Roseveare, D. (2012). *Assessment of Higher Education Learning Outcomes - AHELO Feasibility Study Report.* OECD.

Tuomi, I. (2018). *The Impact of Artificial Intelligence on Learning, Teaching, and Education.* Publications Office of the European Union.

Turing, A. (1950). *COMPUTING MACHINERY AND INTELLIGENCE.*

UN Global Compact. (2016). *About SDGs*. Retrieved August 25, 2018, from UNGlobalCompact: https://www.unglobalcompact.org/sdgs/about

UN World Commission on Environment and Development. (1987). *Our Common Future.* United Nations.

Vincent, J. (2016, Febraury 29). *What counts as artificially intelligent? AI and deep learning, explained.* Retrieved April 29, 2019, from The Verge: https://www.theverge.com/2016/2/29/11133682/deep-learning-ai-explained-machine-learning

Vishwakarma, H. (2018, December 17). *90% of Fortune 500 Companies Use an Applicant Tracking System, what's it?* Retrieved from Medium: https://medium.com/swlh/90-of-fortune-500-companies-use-an-applicant-tracking-system-whats-it-5a6b6d25e5e7

Vuksic, V. B., & Bach, M. P. (2012). Simulation Games in Business Process Management Education. *International Journal of Industrial and Systems Engineering* , 2424-2429.

Waas, T., Hugé, J., Verbruggen, A., & Wright, T. (2011). Sustainable Development: A Bird's Eye View. *Sustainability, 3(10). MDPI AG* , 1637–1661.

*Wade & Wendy* . (n.d.). Retrieved from Wade & Wendy : https://wadeandwendy.ai/

WANG, P. (2008). *What Do You Mean by "AI"?. Artificial General Intelligence.*

Warren, L. (2015, July 9). *Can I Use StrengthsFinder to Make Hiring Decisions?* Retrieved from Gallup Coaching: http://coaching.gallup.com/2015/07/can-i-use-strengthsfinder-to-make.html

WeSchool Bangalore. (2018, July 19). *What-is-the-importance-of-AI*. Retrieved from quora: https://www.quora.com/What-is-the-importance-of-AI

*Why alta?* (n.d.). Retrieved from Knewton: https://www.knewton.com/

Wiggers, K. (2018, October 31). *AISense's Otter for Education brings voice transcription to colleges*. Retrieved from Venture Beat: https://venturebeat.com/2018/10/31/aisenses-otter-for-education-brings-voice-transcription-to-colleges/

WIGGERS, K. (2018, October 31). *AISense's Otter for Education brings voice transcription to colleges*. Retrieved from Venture Beat: https://venturebeat.com/2018/10/31/aisenses-otter-for-education-brings-voice-transcription-to-colleges/

Winston, P. (1992). *Artificial Intelligence (3rd Edition).* Addison-Wesley.

World Commission on Environment and Development. (1987). *Our Common Future.* Oslo.