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THE IMPACT OF ARTIFICIAL INTELLIGENCE ON HIGHER EDUCATION

by

YIZHI MA

A THESIS

Presented to the Faculty of the Graduate School of the

MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

In Partial Fulfillment of the Requirements for the Degree

MASTER OF SCIENCE IN INFORMATION SCIENCE AND TECHNOLOGY

2019

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ABSTRACT

A perfect storm is hitting higher education. Decreased funding from traditional funding sources, such as State Governments, and transformative changes caused by artificial intelligence (AI) will revolutionize higher education. Higher education needs to change and evolve quickly and continuously to prepare students for the upheavals in the job market caused by AI, machine learning, and automation.

As AI continues to make inroads into our world and our lives, its impact and effects can no longer be ignored. What kinds of organizational changes in higher education are necessary? How can higher education continue to prepare students for the AI evolution and revolution, and the resulting job displacements and replacements?

This pedagogical research is a study to investigate organizational and curriculum changes in higher education in the AI era. The research is designed to understand the proactive and reactive organizational and curriculum changes that are necessary in higher education. As one of the pioneering research to investigate the impact of AI on higher education, this research will contribute to academic theorizing and inform the practice and management of higher education.

Keywords: Artificial Intelligence, Higher Education, Organizational Change

ACKNOWLEDGMENTS

I am extremely fortunate to have as my committee members, Dr. Fiona Fui-Hoon Nah and Dr. Sarah Stanley. These brilliant scholars have directed me on my academic path toward doing research and have contributed greatly to my studies. I am grateful for their valuable critiques and encouragement.

I would like to express my gratitude, especially, to my advisor, Dr. Keng Siau. I sincerely appreciate his advice and guidance throughout my Master degree programs. He has been extremely patient and encouraging, and his extensive knowledge, considerable expertise, and unique sensitivity in research have been impressive. It has been an exceptional learning experience, and I am grateful to have had this precious opportunity to learn from him.

I am very grateful to have had this valuable opportunity to learn and work in the Department of Business and Information Technology at Missouri University of Science and Technology. It has provided me with a positive learning environment, cultivated by outstanding faculty as well as supportive administrators and staff. Their efforts cannot be overlooked in assuring the pleasurable, motivating, and interactive learning experiences that I sincerely cherish.

I would also like to thank all my friends who encouraged and supported me throughout my Master degree programs. It has, indeed, been a great time to share this learning journey with you all.

Last, but not least, I am truly grateful to my parents, who have provided me with endless love, unquestionable faith, and continuous support through my studies and my entire life.

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1. INTRODUCTION

As artificial intelligence (AI) continues to advance and its applications are becoming ubiquitous, the significant impact and effect of AI can no longer be ignored (Wang & Siau, 2018; Yang & Siau, 2018). As this new revolutionary technology unfolds, higher education is, unfortunately, one of the areas that has failed to adequately respond to the change. Aoun (2017), the President of Northeastern University, emphasized the potential impact of AI and the role that higher education should play in its development. “People are going to be left out of this economy if we do not step in” (Kornwitz, 2018). AI has been drastically taking over the work and activities in various industries (Siau et al., 2018). Since 2000, for example, more than 5 million manufacturing jobs in the U.S. were eliminated by automation (Long, 2016). Researchers from MIT found that, with every single implementation of a robot in the job field, nearly six people were replaced (Acemoglu & Restrepo, 2017). Similarly, McKinsey Global Institute’s report (2017) predicts that robotics and automation will take over 400 to 800 million current job functions, and people who are holding those positions will have to either switch to other areas or receive retraining in various new skills.

Facing such an unprecedented threat from AI, higher education institutions – “the incubators of human talent”, surprisingly, have not made a clear response towards this phenomenon in the AI age (Aoun, 2017). Unfortunately, this has been happening for a while. In comparison with technological advances, the pace of development in American educational institutions remains far behind (Ramseden, 1992). The same “laissez-faire” attitude, however, will be severely detrimental to the students and institutions in the AI

age. AI is significantly impacting every aspect of human life, and its advancement will most assuredly continue to intensify. Higher education institutions need to catch up with our current technology-enhanced society and assure that students continue to be competitive in today's job market, their alumni remain marketable and employable, and their graduates are able to work in unison and partnership with AI and robots (Ma & Siau, 2018).

With the dawning of the AI era, the skill sets required for the future job market will be distinct from those of the past (Siau, 2017, 2018; Siau et al. 2018; Rainie & Anderson, 2017). In terms of accuracy and consistency, machines have a clear advantage, as compared to humans. Machines can compute quicker, generate information faster with better accuracy, and can process and acquire information consistently and constantly (24/7). It is futile to train students to compete with machines in these dimensions. They need to acquire skill sets that are difficult for AI to learn and develop knowledge that can complement AI capabilities, in order to stay competitive in the job market (Siau, 2018). Siau (2018) points out that AI will make a huge impact in higher education in numerous areas, and organizational and curriculum changes will be two of the major areas impacting this revolution. What curriculum changes should higher education make in order to help its students stay competitive in the AI age? What skill sets should higher education institutions equip their students with to assure that they are marketable and employable in the future job market? What organizational changes are necessary to achieve these goals?

This pedagogical research is a study to investigate and identify organizational and curriculum changes in higher education in the AI era. In this research, we focus on studying the proactive and reactive organizational and curriculum changes that are needed in higher education.

2. LITERATURE REVIEW

2.1. ARTIFICIAL INTELLIGENCE

Artificial intelligence is defined as the ability and development of information technology-based computer systems or other machines to complete the tasks that usually require human intelligence and logical deduction (Poole et al., 1998). Artificial intelligence can be classified as artificial narrow intelligence and artificial general intelligence. Artificial narrow intelligence, also known as “Weak AI”, focuses on one specific narrow task. One example is IBM’s Watson. Watson was designed to be a “question answering” machine that applies machine learning, cognitive computing, natural language processing, and other techniques (Kurzweil, 2010) to achieve superior performance in the game of Jeopardy. Watson has since evolved to function in various domains. Artificial general intelligence (“Strong AI”) involves highly-advanced cognitive abilities that are indistinguishable from those of a human, and can excel in uncertain and unfamiliar tasks (Goertzel & Yu, 2014). Strong AI, according to many, is still at least decades away. In this study, we focus on Weak AI. In the rest of the thesis, AI will refer to artificial narrow intelligence (i.e., Weak AI).

2.2. IMPACT OF AI

PWC research reports that AI will contribute up to 14% of the global GDP by 2030, which is roughly equivalent to \$15.7 trillion. This presents one of the largest commercial opportunities (PWC, 2017) in today’s world. The usage of AI is not limited to recommending books or filtering emails, but encompasses a variety of useful

applications. Virtual assistants (such as Siri, Cortana, Alexa, and Google Assistant) are widely used for anything from ordering an Uber to predicting your needs. AI is ubiquitous and AI applications can be seen everywhere in our lives today. In the financial world, for example, many financial companies have implemented AI technology to monitor fraud and to secure the privacy of their customers' financial accounts. AI technology is also widely used in stock trading. Its applications have been widely adopted in various businesses to improve and develop new products and services, achieve cost efficiencies, accelerate decision-making, and formulate efficient business operations (Mills, 2018; EY Global Innovation, 2018).

AI, however, is a double-edged sword. Although it can help to enhance efficiency and effectiveness, it can also create upheavals in our lives and society (Siau & Wang, 2018; Siau & Yang, 2017). Research conducted by the University of Oxford's Future of Humanity Institute reports that there is a 50% chance that machines will be able to take over all types of human work within the next 120 years. Inputs for this research were solicited from 352 scientists in different areas, and their answers were compiled to predict how long it might take for machines to replace humans in various jobs. Their results indicate that there is a high potential that more than 70% of existing job functions could be replaced by machines in 50 years (Grace et al., 2017).

2.3. CURRENT SITUATION IN HIGHER EDUCATION

As of the 2017–2018 school year, the U.S. government has cut Federal education initiatives by 14% in order to provide more freedom for other educational systems to develop their own focuses based on their specialties. In Western countries, the financial

support received by institutions of higher education depends, primarily, on governmental funding. The latest funding cut will lead to higher costs for higher education. Further, the reduced budget has eliminated a large number of student fellowships and sponsorship programs, which will quite likely lead to a higher student loan rate for higher education (Soffen & Lu, 2017). Some scholars are predicting that 50 percent of the colleges in the U.S. will collapse in 10 to 15 years – by around 2030 (Christensen & Eyring, 2011).

Another critical issue facing higher education in the U.S. is that there are fewer and less tenure and tenure-track professors available. Between 1975 and 2011, the number of tenure and tenure-track faculty in all U.S. educational institutions has dropped from around 45 percent to less than 25 percent (Curtis & Thornton, 2013), and this declining trend is continuing. At the same time, part-time faculty accounts for more than 40 percent of college instructors, with that percentage going even higher. A similar upward trend can also be observed for administrative staff in these institutions. In the University of California system, for example, the number of managers and administrators has more than doubled since 2000 (Christensen et al., 2015). As a result of these negative trends, the current status of higher education can be described as “in a state of flux.”

Because of AI, the traditional job market will continue to shrink, and this will most likely result in the largest number of job replacements and displacements in our history. Undoubtedly, new jobs will be created. Many, however, who are predicting a net job loss, believe that more jobs will be taken away than the number of jobs that will be created. This leads to another question: How affordable will higher education be in the future? Even if the idea of universal basic income is adopted and implemented, will

universal basic income be enough to support the pursuit of higher education, since the goal of a universal basic income is to merely provide for subsistence?

2.4. AI APPLICATIONS IN HIGHER EDUCATION

AI applications have been implemented in almost every industry. Higher education is no exception! Table 2.1 summarizes some of the recent AI applications in the area of higher education.

2.5. AI IMPACTS ON HIGHER EDUCATION

With the job replacements and displacements generated by AI, the future job market and required skill sets will be drastically reshaped by AI (Siau, 2017, 2018). Despite the advancements in technology and its increased use in society, education systems are still regarded as archaic by many (Bok, 2009; Murphy, 2015; Prensky, 2001). Our current higher education systems were designed to fit a far less progressive economy. Accordingly, with the innovation and application of new technologies in the new AI era, higher education institutions need to update and become innovative with new structures and goals that focus on better training and improving services for their constituents and stakeholders (Aoun, 2017; Siau, 2018).

Curriculum changes are among the areas in higher education that will be impacted the most by AI (Siau, 2018). These changes are inevitable due to the constantly changing skill sets required for the future job market. Charles Fadel, the founder of the Center for Curriculum Redesign, says “We need to identify the Essential Content and Core Concepts for each discipline – that’s what the curation effort must achieve so as to leave

time and space for deepening the disciplines' understanding and developing competencies" (The Global Search for Education GSE , 2018). Aoun (2017) argues that three new literacies – technological literacy, data literacy, and human literacy – will enable students to fulfill their social capabilities to make themselves more competitive in the AI era.

Table 2.1. AI Applications in Higher Education

| AI Application | Reference | Function |
|----------------------------------|-------------------------|--|
| Virtual Teaching Assistant | (Online Source) | Able to answer frequently asked questions without the help of humans |
| Personalized Learning | (Online Source) | Apply data analytics to make the learning program adaptable based on various requirements |
| Intelligent Tutoring System | (Online Source) | Apply cognitive science and AI technologies to provide personalized tutoring in real-time |
| Smart Education | (Zhu, et al., 2016) | Use AI technology to make education more effective, efficient, flexible, and comfortable |
| Virtual Lab | (Zakaria, et al., 2011) | Provide students with an online platform with interactive simulations to perform experiments, collect data, etc. |
| Student Learning Assessment Tool | (Jain, et al., 2014) | Apply AI technology to develop a student's specific learning subject by using concept maps |

2.6. CURRICULUM CHANGES

Traditional hard skills, such as natural science, engineering, and economics, will remain useful, as always, due to their specialties and uniqueness. Soft skills, however, are expected to be more significant and essential for an individual to stand out in the future. These skills (including creativity, critical thinking, problem-solving, communication, collaboration, inter-personal skills, leadership, empathy, and adaptability) are becoming more critical because these are skills that are difficult for AI to master in the near future (Pistrui, 2018; Siau, 2018; Tudor, 2017).

Further, higher education curricula need to be responsive to new technological advancements and future job market needs. AI-related education should not only be included in the fields that create and use AI, but should also be taught in many other fields to prepare students with adequate knowledge of AI. Students need to be equipped with the skill sets needed for them to work in partnership with machines and robots. Interdisciplinary courses should be encouraged as diversified knowledge will help build a bridge between AI and relatively specialized fields (Eaton, 2017). This is especially true for fields such as medicine, accounting, law, and architecture, where AI has already made significant inroads.

In addition, disciplines that can help to enhance natural human strengths in other areas, such as the humanities and arts, may become popular in the future as they prepare students to be good assistants and to work alongside machines and robots (Aoun, 2017). To promote this concept, these disciplines may need to be enhanced in many higher education institutions. Emphasis must be on curriculum changes that are both proactive and reactive that can help students achieve personal/professional success.

3. THEORETICAL AND CONCEPTUAL FOUNDATIONS

In this research, we adopted multiple organizational change theories to better understand the impact of AI on higher education and to help generate practical suggestions that focus on the impact of AI.

This section introduces the concept of organizational change and two other widely-adopted organizational change models: Lewin's change management model and McKinsey 7-S model, along with their applications within different fields. Also, with a focus on higher education, two educational change management models (strategy in an educational model and the IDEAS model) were discussed.

3.1. ORGANIZATIONAL CHANGE

Organizational change is both the processes and effects in an organization that changes its structures, strategies, operational methods, technologies, or organizational cultures (Hussain et al., 2016).

Several axioms about organizational change are as follows:

- Organizational changes are intended to be continuous, active, and evolving (Weick & Quinn, 1999).
- Changes that take place in an organizational level are regarded as emergent, and are usually viewed as “a new pattern of organizing in the absence of explicit a priori intentions” (Orlikowski, 1996).
- Changes take place in a continuously updating work processes (Gilbert et al., 1991) and social practices (Tsoukas, 1996).

Highly innovative technology, products, services, and organizational structures enable internal adjustment and adaption of an organization to update and transit to a new level of complexity. An organizational change includes the reforms of workloads, business models, products, and services, along with revised processes and remuneration structures of an organization (Vasconcelos et al., 2017).

Two popular organizational change models, the Lewin's Change Management Model and the McKinsey 7-s model, will be reviewed next.

3.2. LEWIN'S CHANGE MANAGEMENT MODEL

Lewin's (1946) change management model is one of the most well-known organizational change models that has been widely adopted successfully within different organizations. Lewin argues that a successful change happens with a three-step process -- unfreezing stage, changing stage, and refreezing stage (Levasseur, 2001).

Lewin's change management model (including the three major steps) is shown in Figure 3.1.

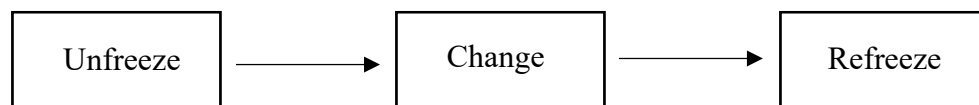


Figure 3.1. Lewin's Change Management Model

The unfreezing stage refers to the stage in which the concept of change is first proposed, and it is addressed in the initial phase. As it is human nature to avoid changes, it takes time for people to process a proposal for changes to the point of taking actions that will make those changes happen.

When people have accepted the proposed changes, and start to make the changes work, that is the change stage. After the transition is over, the refreezing stage takes place to make sure that the changed aspects remain.

The Lewin's model has been widely used in academic research and some of the organizations that employed Lewin's model are summarized in Table 3.1.

Table 3.1. Applications that applied Lewin's Change Management Model

| Application | Reference | Summary |
|--|-----------------------------|---|
| Adopting a personal digital assistant system: application of Lewin's change theory | (Lee, 2006) | This research studied nurses' perceptions of applying a handheld computer personal digital assistant in their daily work. The researcher found that the results matched the three stages proposed by Lewin's. |
| Hospital Setting | (Šuc, et al., 2009) | A project conducted at the University Hospital Erlangen applied Lewin's change management model to an information documentation changing project successfully. |
| Operation management environment | (Bamford & Forrester, 2003) | This research studied various change management models and contributed to a better understanding of the applications of different change management models for operation managers. |
| Engineering and construction | (Lines, et. al., 2015) | This study measured the impact of different change management factors and applied Lewin's theory to minimize the resistance. |
| Bar-coded medication administration | (Sutherland, 2013) | This study implemented Lewin's change management model to better understand technological advancement in the healthcare environment. Lewin's theory identified the processes during the transition and helped to smooth the transition. |

3.3. MCKINSEY 7-S MODEL

The McKinsey 7-S model is a management model created in the early 1980s by Waterman and Peters (1980). It provides an integrated method for operating the changes in an organization, and it includes seven internal aspects that need to be in operation as collective agents of change: Shared Values/Superordinate Goals, Strategy, Structure, Systems, Style, Staff, and Skills (see Figure 3.2).

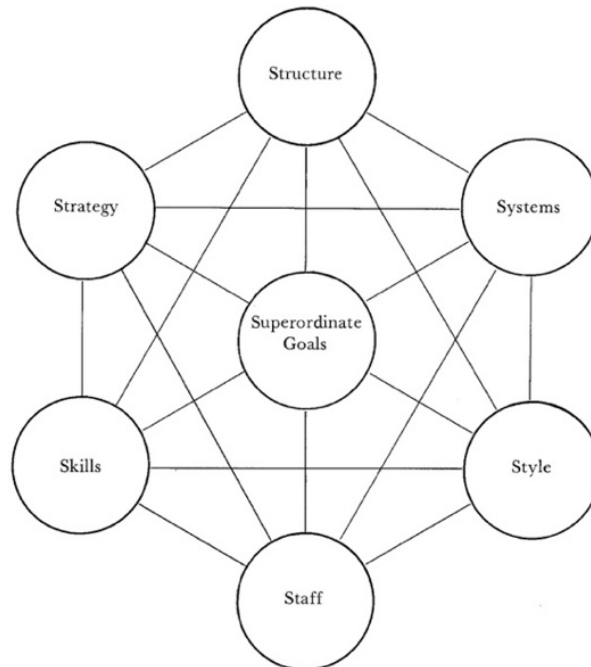


Figure 3.2. McKinsey “7-S” Model

In practice, the McKinsey 7-S model is mostly used as an organizational analysis tool to monitor and evaluate the internal and external changes within an organization. Some research organizations that utilize this model are summarized in Table 3.2.

Table 3.2. Applications applied to McKinsey 7-S Model

| Applications | Reference | Summary |
|---|------------------------------|---|
| Effective strategy implementation | (Baroto, et al., 2014) | This study applied McKinsey 7-S model as a resource-based view to help the organizations execute the strategy more efficiently. |
| E-transformation | (Arunatileka & Ginige, 2003) | This research provided a clear analysis of a successful e-transformation under McKinsey 7-S model and highlighted the importance of the 7 processes during the transition. |
| Achieving organizational excellence | (Singh, 2013) | This study illustrated how McKinsey 7-S framework is the model for organizational analysis and its effectiveness analysis. |
| MBA strategic management curriculum development | (O'Shannassy, et al., 2010) | This study implemented McKinsey 7-S model to learn how training supplies for employees can benefit the Australian workplace and how that would help increase practical efficiency and creativity. |

3.4. STRATEGY IN EDUCATION MODEL

This model, which was first proposed by Scott Eacott in 2008, was designed to address the model of strategic management and leadership, especially within educational organizations.

As Figure 3.3 illustrates, this model shows the relationship between the strategic roles of leadership and five inter-related attributes (Envisioning, Engaging, Articulating, Implementing, and Monitoring) within educational institutions. It emphasizes the role of

educational strategic leadership, which is the key in a relatively more dynamic and repetitive process (Eacott, 2008).

Strategy is used to determine the foundation and to settle certain long-term objectives for prospective changes within educational institutions (Sanyal & Martin, 1992).

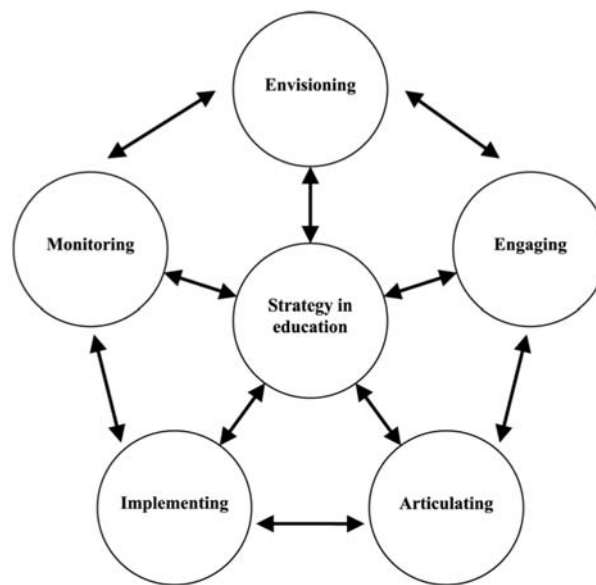


Figure 3.3. Strategy in Education Model

3.5. THE IDEAS MODEL

The IDEAS Model, proposed by Andrews (2008), is designed to help assure the alignment between work within schools and the focus of strategic policies. It intends to guide educational institutions forward to a path of self-discovery and enhancing excellent performance in both processes of teaching and learning (Andrews & Crowther, 2003).

Five phases are introduced in this model:

- Initiation – planning the process
- Discovery – surveying school stakeholders
- Envisioning – creating a vision for the school
- Action – developing an action plan
- Sustaining – monitoring progress, including the development of a School-wide Pedagogy that is unique to a particular school.

This study is designed to be at the “discovery” phase in the IDEAS model. By interviewing the stakeholders of higher education, this study aims to create a vision for higher education institutions, in general, with a focus on the impact of AI through the use of survey results collected during preliminary investigations, in conjunction with the current situations existing in higher education.

4. RESEARCH METHODOLOGY

This study consists of two parts – a survey and an interview. The survey aims to collect demographic data from each participant, as well as measure their attitudes with regard to technology. Personal interviews were conducted to identify the impact of AI on higher education. The interview methodology is one of the most commonly used techniques for collecting qualitative data since it is a useful way for researchers to obtain various viewpoints from participants, along with relative background stories based on personal experiences. This methodology allows the interviewers to have more direct interaction with participants, which helps in arriving at a comprehensive understanding of the topic (McNamara, 1999).

4.1. SURVEY INSTRUMENT

The first part of the survey was the collection of demographic information from the study participants – age, gender, education level, and current occupation – as well as relevant information and self-evaluation in terms of AI knowledge. We used a 7-point Likert scale (Extremely Unknowledgeable, Quite Unknowledgeable, Slightly Unknowledgeable, Neither, Slightly Knowledgeable, Quite Knowledgeable, Extremely Knowledgeable) for responses to the question: “How much do you know about Artificial Intelligence?”

In the second part of the survey, four constructs were measured using a 5-point Likert scale: 1- Strongly Disagree, 2 - Disagree, 3 - Neither Agree Nor Disagree, 4 - Agree, 5 - Strongly Agree. The measurement items were adopted from previous studies.

The four constructs are: affinity for technology (Edison & Geissler, 2003), anxiety about being without technology or dependence on technology (Gokhale et al., 2009), positive attitudes toward technology, and negative attitudes toward technology (Rosen et al., 2013).

4.2. INTERVIEW PROCESS

All participants were asked to participate in a face-to-face interview with the researchers. Two introductory videos were presented initially to provide some basic knowledge about AI development and job replacement trends. All interview sessions were recorded audibly after receiving consent from the participants.

Fourteen questions were included in the interview. They cover: (i) the concept of AI; (ii) expectations of AI capabilities; (iii) personal views and concerns about job replacement due to AI; (iv) impact of AI on higher education; (v) expectations for changes and responses from higher education faced with AI challenges; (vi) impact of AI on the future of humanity and society.

In addition, our participants were also asked how they would prepare themselves to maintain their competitiveness in the future job market in response to the threat of AI displacement. The goal was to establish a practical guideline for the public to address such concerns.

5. ANALYSIS OF RESULTS

Fifty participants were interviewed for this study, including students, faculty, staff, and professionals who are employed, or have worked, with institutions of higher education. The participants represented various backgrounds that include science, engineering, social science, and arts/humanities.

5.1. SURVEY RESULT ANALYSIS

The analysis of survey results is presented in the following section, including demographic information and analyses of the four measured constructs respectively.

5.1.1. Demographic Information. A total of 23 males and 27 females participated in the study. They have different backgrounds, such as science, engineering, technology, and mathematics, as well as different jobs, such as university administrators, educators, students, faculty members, campus staff, as well as other professionals from industry.

The mode of the ages of participants is in the range of 25-34 (i.e., 20 individuals). The ages of 21 participants fall in the range of 18 to 24 years, and the ages of five participants fall in the range of 35 and 44. There is only one participant whose age falls within the 45-54 year category. The ages of three participants are above 55.

For their level of highest education, more than half (38/50) of the participants have at least a Bachelor's degree, with 15 of them having a Master's degree, and five of them a Ph.D. degree. Five participants have high school degrees, and seven have either some college education or no degree.

Thirteen of the participants are undergraduate students; 16 are Master's students; five are Ph.D. students; five are faculty members, and two are administrators. All of them are from Missouri University of Science and Technology. Nine of the remaining individuals are working in other fields, such as staff or office support at higher education institutions as well as project coordinators, consultants, administrators, and managers from industry.

Additionally, we have one question for participants to self-evaluate their knowledge of AI. The results indicate an average value of 4.7 on a scale of 1 to 7 (i.e., 1 – Extremely Unknowledgeable, 2 – Quite Unknowledgeable, 3 – Slightly Unknowledgeable, 4 – Neither Unknowledgeable or Knowledgeable, 5 – Slightly Knowledgeable, 6 – Quite Knowledgeable, 7 – Extremely Knowledgeable). This result suggests that the average knowledge of AI is between Neither to Slightly Knowledgeable.

Table 5.1. Summary of Demographic Information

| Age Information | |
|---------------------------|----|
| Under 18 | 0 |
| 18 - 24 | 21 |
| 24 - 34 | 20 |
| 35 - 44 | 5 |
| 45 - 54 | 1 |
| 55 and above | 3 |
| Gender Information | |
| Male | 23 |
| Female | 27 |

Table 5.1. Summary of Demographic Information (cont.)

| Education Level | |
|--|-----|
| Less than a high school diploma | 0 |
| High school degree or equivalent | 5 |
| Some college/no degree | 7 |
| Associate degree | 0 |
| Bachelor's degree | 18 |
| Master's degree | 15 |
| Professional degree | 0 |
| Doctorate or higher | 5 |
| What is your current occupation? | |
| Undergraduate student | 13 |
| Master's student | 16 |
| Ph.D. student | 5 |
| Faculty | 5 |
| Administrator | 2 |
| Other | 9 |
| How much do you know about Artificial Intelligence? | |
| Average | 4.7 |

5.1.2. Questionnaire Result Analysis. This section includes quantitative analysis of the survey questionnaire. There are 22 questions in the survey. The survey was designed to collect information regarding the relationship between each individual and technology from four different aspects: affinity for technology, anxiety about being without technology or dependence on technology, and positive and negative attitude toward technology. A 5-point Likert scale was used.

5.1.2.1. Affinity for technology. The results of this construct are presented in Table 5.2. The scale was adopted from a study by Edison & Geissler (2013), which was adopted from other previous studies, including Parasuraman (2000), Rosen et al. (1993), Heinssen et al. (1987), Simpson and Troost (1982). The Cronbach's alpha coefficients, from previous studies, are 0.88 and 0.892, respectively. For our study, the Cronbach's alpha coefficient is 0.87, and we found a mean of 3.89 for this construct, indicating a positive relationship towards technology.

Table 5.2. Affinity for Technology

| Survey Question | Affinity for technology | Average |
|-----------------|---|---------|
| 1 | Technology is my friend. | 4.16 |
| 2 | I enjoy learning new computer programs and hearing about new technologies. | 4.02 |
| 3 | People expect me to know about technology and I don't want to let them down. | 3.56 |
| 4 | If I am given an assignment that requires that I learn to use a new program or how to use a machine, I usually succeed. | 3.86 |
| 5 | I relate well to technology and machines. | 3.86 |
| 6 | I am comfortable learning new technology. | 4.14 |
| 7 | I know how to deal with technological malfunctions or problems. | 3.32 |
| 8 | Solving a technological problem seems like a fun challenge. | 3.32 |
| 9 | I find most technology easy to learn. | 3.4 |
| 10 | I feel as up-to-date on technology as my peers. | 3.66 |
| 11 | I feel it is important to be able to find any information whenever I want online. | 4.42 |

Table 5.2. Affinity for Technology (cont.)

| | | |
|--------------------|---|------|
| 12 | I feel it is important to be able to access the Internet any time I want. | 4.68 |
| 13 | I think it is important to keep up with the latest trends in technology. | 4.12 |
| Mean | | 3.89 |
| Standard Deviation | | 0.42 |

5.1.2.2. Anxiety about being without technology or dependence on

technology. This scale was adopted from the work of Gokhale et al. (2009), which measured anxiety using three different scenarios that included not having a cell phone, an internet, or technology. For our study, the Cronbach's alpha coefficient is 0.787. As Table 5.3 has shown, the participants' average indicates slightly positive anxiety about being without technology.

Table 5.3. Anxiety About Being Without Technology or Dependence on Technology

| Survey Questions | Anxiety About Being Without Technology or Dependence on Technology | Average |
|--------------------|--|---------|
| 14 | I get anxious when I don't have my cell phone. | 3.62 |
| 15 | I get anxious when I don't have the Internet available to me. | 3.78 |
| 16 | I am dependent on my technology. | 3.56 |
| Mean | | 3.65 |
| Standard Deviation | | 0.11 |

5.1.2.3. Positive attitudes toward technology. This scale focused on measuring the positive attitude of each participant toward technology, which was adopted from Rosen et al., (2013). This construct has a mean of 3.97, as shown in Table 5.4. This result shows a positive attitude toward technology. The Cronbach's alpha coefficient is 0.64 for this construct.

Table 5.4. Positive Attitudes Toward Technology

| Survey Questions | Positive Attitudes Toward Technology | Average |
|--------------------|--|---------|
| 17 | Technology will provide solutions to many of our problems. | 4.34 |
| 18 | With technology, anything is possible. | 3.58 |
| 19 | I feel that I get more accomplished because of technology. | 4 |
| Mean | | 3.97 |
| Standard deviation | | 0.38 |

5.1.2.4. Negative attitudes toward technology. This scale is also adopted from Rosen et al., (2013), but it measures negative attitudes toward technology. As Table 5.5 shows, the Cronbach's alpha coefficient is 0.59 for this construct, with a mean of 3.17 for responses, indicating that most participants have a marginally positive attitude towards technology.

Table 5.5. Negative Attitudes Toward Technology

| Survey Questions | Negative Attitudes Toward Technology | Average |
|--------------------|--|---------|
| 20 | New technology makes people waste too much time. | 3.12 |
| 21 | New technology makes life more complicated. | 2.76 |
| 22 | New technology makes people more isolated. | 3.64 |
| Mean | | 3.17 |
| Standard Deviation | | 0.62 |

5.2. ANALYSIS OF INTERVIEWS

The responses in the interviews were summarized into keywords, and then input for visualization by using the WordCloud application (<https://www.jasondavies.com/wordcloud/>). WordCloud is a popular visualization tool to interpret qualitative data, especially text data. It is used to generate an image denoting text keywords, and to vary the terms in size, based on the frequency of appearances and the prominence of each term.

Summaries of responses to all questions are paraphrased below, with their WordCloud maps attached.

5.2.1. Interview Question 1. Figure 5.1 shows the WordCloud map analysis of the first interview question: What do you think AI is? The figure shows FunctionLikeHuman as the most common concept among all responses. This suggests that the general understanding about AI among our participants was based more on its

functionality perspective, i.e., to make technology functions like those of humans, and “similar to the human brain functions while processing tasks in the way that human brains do” (Subject 31). “It is part of a computer program that acts with human rationality, although it is an artificially created program that can automate things or help with tasks that humans do not want to do, or cannot do easily”.

Two other common keywords, ThinkLikeHuman and SelfLearning, denote “make machines and computers to replicate the way humans think and to make them able to learn by themselves” (Subject 12). The focus is more from an internal perspective of the basis for AI. As Subject 6 said, “AI is a tool that is currently built by humans, is something that should be able to learn by itself in the future, and to work on the tasks that people are normally doing. AI not only does tasks that require logic, but also tasks that require deeper thinking”. Subject 38 understood that AI was “human-made intelligence, to use current existing data and pre-designed tools to predict what might be happening in the future.” Similarly, Subject 42 defined AI as “human made intelligence that is based on different learning procedures accumulated from input data, and used to learn from that. It builds off of learning processes to generate intelligence of its own, and reaching to where it can perform tasks on its own.”

HumanSimulation and ImproveLife were also mentioned. Subject 44 mentioned “the idea of turning machines and make machines able to think like humans and perform human-like tasks in a way that it can either improve productivity or even replace an entire humans process, like a job or an environment”. “AI is built to perform tasks like humans and does work for humans, so as to allow humans to have more time and energy for the

tasks that require human talents. Also, AI is designed to make a better life for humans, it is a tool that can assist with human life (Subject 32)”.

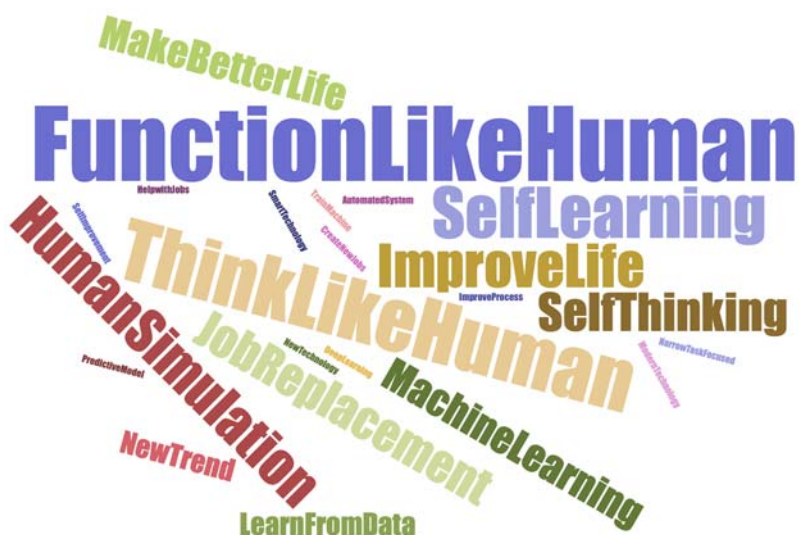


Figure 5.1. WordCloud Map - Question 1.

5.2.2. Interview Question 2. Figure 5.2 is the WordCloud map for the second question in the interview process: What do you expect AI to do in the future? As the map indicates, HelpWithWork appears most often among all the responses. “To help remove unnecessary human interaction from the jobs that can be done more efficiently using computer power” (Subject 22).

Subject 11 adds that: “helping people with dangerous jobs, like rescuing people in an earthquake. Also, help with dirty, mechanical, and simple jobs for humans.” Similarly, “I expect AI to help with a lot of things, such as help with video/audio editing, file editing, assignments, and hopefully it could be able to help with writing some essays from a personal perspective” (Subject 14).

ImproveLife, HighLevelJobs4Human, DoEverything are other phrases that appear with a significant frequency. Helping with improving the quality of life, providing more high-end jobs that are complicated and unstructured, as well as helping to do everything in people's lives are among expectations described for AI. "I hope AI could provide more convenience and benefits for people, and help make our lives more comfortable and of a better quality" (Subject 36). Subject 30 elaborates: "AI implementations allow the work that is repetitive and mundane to be replaced. It is also able to integrate AI automatically into the methods for processing those tasks. This case would then give humans more time to work on other tasks that they are passionate about, or that requires the in-depth intelligence of a human".

Subject 33 says: "AI will make things easier. For example, AI could help humans to work on different tasks. It would be able to complete multi-step tasks within one step, hypothetically, and make complicated tasks easier to achieve. Although we might not be able to use AI for the complicated tasks that require decision-making capabilities, we can still use AI for simple tasks in a much faster way with better efficiency." In terms of AI potentially being capable of doing everything, Subject 5 mentions: "AI will be capable of pretty much anything. It is going to learn what humans expect it to do, and to do what humans govern it to do, and what humans allow it to do".

5.2.3. Interview Question 3. Figure 5.3 shows a WordCloud map of the responses to the question: What is your view of AI taking over some jobs in the future? JobReplacement is the most-mentioned phrase, and most of the participants agree with the fact that major job replacements would be one of the massive changes that AI would

bring. “This is acceptable, and it will happen. AI will help people improve their lives. AI can make jobs easier, and AI can take over the dangerous and dirty jobs” (Subject 11).



Figure 5.2. WordCloud Map - Question 2.

CreateNewJob is the next most-mentioned keyword. Not only are people expecting AI to take over jobs, but they are also expecting AI to create new jobs as its implementation moves forward. “It’s probably the best for AI to take over the jobs in the future and lead to new job creation at the same time; the redundant jobs will be replaced and more jobs requiring human intelligence will be created. Overall, it is better for humanity to move forward” (Subject 3). In other words, Subject 15 states that: “AI will take some jobs, whereas there will be other jobs related to AI. That is always the case with technology, it will take some jobs away, but it will create jobs too. Eventually, it will reach a balance”.

Inevitable and TakeLowLevelJob are other common keywords. People believed that AI taking over jobs was inevitable, especially the low-level jobs. “It’s inevitable for any new technology. The same thing happened during the industrial revolution where

Although many participants agreed on the threats that AI would bring to the future job market, this does not translate into a matter of concern. Subject 3 indicated that “as AI is taking over jobs, it will create some new jobs that require humans to manage AI, or to work in association with AI”. Similarly, Subject 19 also indicates that: “if AI takes some jobs in the future, humans will just work on other jobs. For example, AI will take over the dangerous jobs, and the jobs that humans do not want to do. Humans can switch to monitoring AI, or go to work on other jobs.”

There were also views with a focus on the current developmental status of AI, “it will optimize some part of the work, but cannot fully replace my job in a short time” (Subject 46).

Subject 11 shared: “AI can take over some jobs that need technical skills because they outperform humans. But, for the jobs that require soft skills, AI cannot replace humans.” They believe, however, that even though AI might be able to handle the workload itself, it would not have the comprehensive capabilities to fully take over some positions due to lacking the human touch or related human skills.

Further, some participants believe that, as long as the way AI is implemented is right, job replacements by AI should not be a concern. In other words, “if we implement AI incorrectly, there will be an outcome of concern , but if we do it right, there should not be a problem. For example, if we have good retraining programs for the people who are losing their jobs to AI, I wouldn't be concerned about the future as long as people are being retrained to be qualified enough for the coming new jobs” (Subject 23). Subject 31 agrees with this view: “people need to further their education, if possible, to get jobs that will better diversify them that AI cannot do at that time.”

The image shows a word cloud map for Question 4. The words 'Not Concerned' and 'Concerned' are the most prominent, displayed in a large, bold, orange font. The word 'Not' is positioned above 'Concerned', and 'Concerned' is positioned below 'Not'. The words are centered and take up most of the space.

Figure 5.4. WordCloud Map - Question 4.

5.2.5. Interview Question 5. Figure 5.5 shows responses to the fifth question: Are you concerned about AI taking over your job in the future? The responses are consistent in comparison to the answers for the previous question. Most participants indicated that they were not concerned with AI taking over their jobs.

Many other views centered on the current state of AI: “currently, AI is mostly based on recognizing patterns and learning from known, existing data” (Subject 2), whereas not all the jobs are formatted in patterns within the range of known facts. “I believe there will still be the need for human intervention in the job area. Hence, I don’t foresee AI being completely independent of humans” (Subject 4). “AI is a tool you can use to help yourself in your job, try to work with AI, and see it as an ally rather than a competitor,” as Subject 3 said. Learning to use and cooperate with AI is more essential, at this point, rather than fearing AI.

Meanwhile, some participants proposed that switching jobs was always an option. If their current jobs are replaced by AI, they would consider switching their jobs to other fields that are not facing AI threats. Therefore, they do not take AI’s replacements of jobs as an issue of concern.



Figure 5.5. WordCloud Map - Question 5

5.2.6. Interview Question 6. The sixth question is: Do you think your job will be taken over by AI in the future? This question was designed to focus on the situation in 5 to 20 years, and to ask our participants if they believe that AI will replace their jobs in the future. Responses to this question are depicted in Figure 5.6.

DoNotThinkSo is the most common key word, the number of appearances of ThinkSo and Depends were relatively even. A few participants responded as being NotSure to this question.

Some participants did not believe that AI will be able to take over their jobs in the future. Based on their professional background and understanding of AI capabilities, these views varied. The different viewpoints are summarized, as follows:

- For jobs that require the advantages of a human’s unique approach (i.e., human touch, human emotions, creativity, and critical thinking), it would be nearly impossible for AI to take over such functions due to its limitations. Thus, the jobs that require such skills should be relatively safe from alteration or elimination. Subject 25, who works in the user experience field, says; “you need to communicate with people, understand people to work in this field. So, I don't think AI would take my place. I would probably be on the side of creating and developing AI for people, based on their needs and preferences, etc.”

- High-end positions, that are highly technical, should be relatively safe from replacement by AI, especially in fields that involve developing, upgrading, and maintaining AI. Those particular functions would be more difficult for AI to take over in a short time.
- Some participants said that, even if AI could perform most of the tasks covered by one position, it would still be hard for AI to take over that job entirely. Such a replacement would be limited to the specific functions that were assigned to the position. Human interaction and human monitoring would always be required to successfully perform the functions and do the job.. AI's impact would be more on job transitioning, rather than job replacement.
- Further, learning capability was proposed as the key to surviving in the future job market. To keep learning and keep improving oneself would be essential for anyone to remain competitive when facing job replacement by AI.

Some participants agreed that AI replacement was possible in the future. Subject 6 (who works as a consultant) shared: “working in the consulting field, which is to solve all sorts of problems that face clients, can positively be taken over by AI. Most of the problems at a work place focus on whether to streamline some functions; which tool to choose; what part of the work to optimize; or whether to bring in a completely new idea that the company has never used and help to implement it. These work tasks have already been partially taken over by AI, and can be entirely taken over by AI as it is developed further.”

Similarly, Subject 13 expressed some concerns of the industrial psychology field: “some of the employees’ evaluations and polygraph tests have already been taken over by

AI. The need for humans to work within the industrial psychology field now has shrunk drastically, let alone in the future. AI replacement would be a huge issue for people in my field, especially in the view of employers. Most companies would be more likely to choose to hire fewer people to monitor the processes, and to implement more AI-based applications to complete real tasks.” Also, Subject 7 believed that: “AI would have capabilities for taking over everything, as the goal is to eventually achieve maximum utilization of AI. When AI technology reaches the level where AI is generally used, it will probably take over all jobs”.

For participants who said: “it depends on the situation”, the views were centered on two perspectives. Subject 4 said: “it will depend on what I will be doing by that time”, and Subject 18 also indicated that “it would depend on personal choice as to which field to get into, as well as learning capabilities”.



Figure 5.6. WordCloud Map - Question 6.

5.2.7. Interview Question 7. The seventh question was: How do you think higher education will be impacted by AI? The responses to this question are depicted in Figure 5.7. As the WordCloud map shows, there are four phrases that stand out,: GreatImpact, TechnologyFocus, AIFocus, and LearnAI.

GreatImpact represents the view that AI will have a tremendous impact on higher education. This view can be discussed from two dimensions. On one hand, participants thought that AI would have a great impact on our whole society. Higher education, as one element of society, would be greatly impacted as well. On the other hand, higher education will be more drastically affected because of its role in our society. Higher education will be even more important as greater in-depth knowledge and more complex technical skills become more critical for employees to remain competitive in the AI era. Further, curricular setup, delivery systems, tutoring methods, and other factors will be significantly impacted as well.

TechnologyFocus was another common keyword. This suggested that including technology and technical knowledge in teaching materials should be the focus of higher education. “Courses need to be adjusted towards a more technological focus, and everything needs to be centered on AI’s technological applications. Teaching purposes within the higher education realm need to switch from theoretical concepts to practical technological-based knowledge” (Subject 36). In addition, adopting more technological-advanced facilities for higher education should be another focus, such as special assistance with teaching and grading. “Higher education can work on improving AI, but it can also use AI to improve its performance. Higher education has not been personalized previously but, with the help of AI, each individual will be able to learn at one's own pace. In general, AI can improve information processing, which should help students learn much easier and faster” (Subject 19).

LearnAI, and AIFocus were also common keywords. They suggested the importance of learning AI.

First, adaptability was one concern, as Subject 44 said: “higher education will adapt to AI as much as it adapted to computers and automation in the past industrial revolution. Higher education is a very “adaptive” field, and most colleges are good at recognizing the impact of technology advancement and improving their curriculum to catch up. Only by doing so, can they teach students better and work better with AI”.

Second, learning AI is not limited to only understanding AI technology, but more focus must be on merging “AI related information into all departments, as AI will become more involved with everything. Although everyone does not need to learn how to write code to develop AI, people must know more about how AI, in general, affects their lives. Just as calculators are still being used nowadays, AI and its applications are likely to become as common in the future as the role calculators are playing today” (Subject 9).



Figure 5.7. WordCloud Map - Question 7.

5.2.8. Interview Question 8. The eighth interview question asked: What should higher education do to address the challenges posed by AI? The responses are represented in Figure 5.8.

TeachAI appears most frequently among all the keywords. Most participants agree that teaching AI should be the new focus within higher education. Subject 41 says: “higher education should start to include more about AI, such as its history; how it has been developed; how it has evolved; and what it can do. Not only should teaching be from a theoretical perspective, but also the students should be encouraged to engage in practical experiments, and hands-on experiences should be required”. “Higher education needs to heavily incorporate AI knowledge into different fields, as well as to teach students to understand how the technology works and how to work with it. Higher education should prepare its students with a mindset for using AI, instead of avoiding it in the future” (Subject 23).

TechnologyFocus is another commonly-occurring term. Subject 7 said that: “higher education should focus more on the technology side, so it should teach more skills that relate to AI technology. People will need appropriate technologically-based skills to work better in the future”. Also, Subject 33 says: “we need to get knowledge of updated technology, and to change the curriculum accordingly. Higher education shouldn’t be stuck with the same knowledge focuses over and over again, through the years. Students should be exposed to more cutting-edge and practical knowledge about technology. Higher education should give them more flexibility to get familiar with technology, and how to use that technology.” Most participants believe that it is very

necessary for higher education to switch its focus from where it is now, and to make changes in response to the AI age.

In addition, CurriculumChange, WorkWithAI, TechnicalSkills, PracticalSkills, AdaptTheTrend, and HelpWithWork were also mentioned by a significant number of participants in our study.

Many of the participants believed that curriculum changes are inevitable for higher education to succeed in the AI age. It needs to focus more on the technology and AI concepts as its impending full implementation is getting more critical. Higher education also needs to work on enriching the practical skills of its students as well as including information concerning practical skills in the curriculum. These skills will become more essential because of the job replacement threat posed by AI. Without a doubt, AI has unbeatable advantages over us when it comes to obtaining and processing data.

Apart from skills preparation, accepting AI and being able to work in conjunction with AI are also important for students to succeed in the future job market. AI is certain to be “tightly coupled” with human life in the future, as it will be merged into people’s life in a variety of different aspects. Thus, higher education needs to prepare students with an appropriate mindset and to carefully guide them through this process.

5.2.9. Interview Question 9. Figure 5.9 is the WordCloud map for Question 9: What are the changes necessary in higher education to address the challenges posed by AI? These high-frequency words are consistent with the preview question: TeachAI and TechnologyFocus.



Figure 5.8. WordCloud Map - Question 8.

Most participants indicated that the curriculum presented by higher education should be shifted more towards technology. Also, participants thought that, not only should the knowledge of technology be addressed within STEM (science, technology, engineering, mathematics) fields but, also, it needs to be incorporated within all different fields, including the business and liberal arts departments. Since working with AI will be the “norm” in the future, everyone in every field will need to have some knowledge about technology and AI. As Subject 41 indicated that: “higher education should start to include more about AI, its history, how it has evolved, and what it can do.”

In addition, more in-depth knowledge should also be included for those fields that are closely related to AI. This should be, not only from a theoretical aspect, but it should also include more opportunities for students to work with AI, or even to use AI to study. Thus, students would be able to gain practical experience and become more confident in working with AI.

5.2.10. Interview Question 10. Figure 5.10 is the WordCloud map for Question 10: What should higher education do to address the impact of AI on the future of work and humanity? This question brings out a new dimension of the impact that comes with AI, the humanity and ethical aspects.

Aside from the keywords that appeared frequently in the previous questions (TeachAI, AIFocus, LearnAI, TechnologyFocus, and AcceptAI), SituationAwareness was a new concept that was proposed pragmatically, with a special concern for humanity and ethical issues.

Subject 10 believed that higher education needs to teach its students to appreciate the importance of understanding AI, and the processes of AI. “To be the first one to tell the public of the importance of learning AI, to explain possible positive and negative impacts that AI might have, to make people aware of what is coming next, and to help them begin preparing for the future” (Subject 10).

Subject 31 said: “higher education should evaluate where the industry is heading and where AI is moving, as well as the weaknesses of AI, so that teaching materials will be available, and students can focus on those areas (e.g., creativity, public speaking, etc.) Higher education needs to teach students how to use AI appropriately, what the future social norm will be with additional AI implementation.” To inform students and the general public about AI’s capabilities and its possible impact will be a primary duty of higher education. It is important for those in higher education to raise the awareness of students and the public to AI’s potential impact on our society.

Subject 48 also commented on this point of view by saying: “Alerting people to the situation, and teaching them how to use technology, instead of being afraid of technology, is very important”.



Figure 5.10. WordCloud Map - Question 10.

5.2.11. Interview Question 11. Figure 5.11 is the WordCloud map for Question 11: How can you prepare yourself for the future when AI is going to replace some jobs? Similar to response for the previous questions, LearnTechnology, and LearnNewTechnology are the most common suggestions in terms of getting prepared for the AI age.

In order to stay competitive in the future job market, Subject 2 says that: “always improving and constantly learning” will be the key solution for the job replacement threat posed by AI. “The more skills a person has, the more competitive that person can be in

Interpretations of the collected responses for this question are shown in Figure 5.12. TechnicalCapability was the most common keyword among all responses. Most participants believed that technical capabilities will be the most critical skill in the future job market. Subject 43 said: “for the reason that more jobs will require people to work with AI, the capability of understanding AI technology will become a required skill for human workers. Thus, humans will need to learn more about AI and the skills that could help them work with it, especially certain technical skills.” Similarly, Subject 16 also said that: “more people with higher technical skills will get better work with AI, or will work on AI”.

From the future wage perspective, overall, most participants believed that wages would go up, as the available jobs for people would be more technically-driven. People who are considered AI-immune, will have higher wages as their skillsets will be more irreplaceable and impossible for AI to adopt.

Most participants believed that future jobs will be highly technical. However, Subject 26 brings up an interesting perspective in terms of future jobs in general, saying that: “one important role of AI in the future job market will be to separate the people who want to work, from the ones who do not want to work. AI will push those who want to work to be able to work harder with its help, and to achieve the best results. This group of people would not lose their jobs to AI and, correspondingly, their wages would go up, whereas people, who do not feel like working, will be at greater risk of losing their jobs to AI.”

evolve. It is hard to say at this moment if humans will be better or worse off since that depends on how people use AI. With the additional power that AI provides, humans can definitely be worse off if they do not know exactly how to use AI. It is really important for humans to apply AI properly and in the right way”.

Other than Depends, there was an even split between Better and Worse. The number of our participants, who believed that future humanity would be better, remained relatively the same as the number who thought that the future of humanity would be worse with more implementation of AI.

For the participants who believed humans will be better off, most of them held the view that AI would bring about “better communications, improved facilities, higher living standards, better living style and, hopefully, better incomes as well. Generally, technology tends to improve life so, whatever it takes, lives are improved” (Subject 15). Meanwhile, Subject 12 also supported this view by saying that: “there will be some negative impacts, but also good ones as well. Humans will move forward with good and bad aspects affecting humanity all along. Going through the different phases of our history, humans have been constantly. However, these changes are also the characteristics that have helped us make history. So, it will be better for humans to accept changes, and it will take some time for us to eventually succeed”.

For the views concerning how AI would make humans worse, Subject 10 cites a specific example: “the crime rate will increase with increased implementation of AI. Since many people will lose their jobs, they might become pressured and more depressed. Such negative emotions could possibly lead to unhealthy competition between people, and promote certain psychological issues too.” Further, Subject 5 says: “with more AI

implementations in the future, people will rely more on AI and technology. This cause humans to become lazier, more socially awkward, and more isolated.”



Figure 5.13. WordCloud Map - Question 13.

5.2.14. Interview Question 14. Question 14 asked: What is your opinion of the future of society (i.e., will society be better or worse off because of AI)?

However, by comparison to Question 13, interpretations of responses to Question 14 are more distinct, shows in Figure 5.14.

Depends was still the most common keyword, yet more participants believed that society would become better, rather than worse, with further implementation of AI.

Most participants held the view that the future of society will depend on how people use AI. Subject 41 believed that the future of society would depend on how people use AI, saying that: “technology can be used to construct, but it can also destruct. So does AI; the future it will depend on which side it will be used”. There were also participants that believed that the future of society will depend heavily on the person who has the power to implement AI in society, and the people who use AI.

Many more participants believed that society would be better with additional AI implementations. “More AI implementation would lead to more free time for us.

Productivity and efficiency will be improved with the help of AI, and we will have more time to interact with one another and take advantage of our interests” (Subject 15).

Besides, Subject 34 said that: “the coming AI age is like the last revolution when human labor was greatly liberated by automations. Similarly, people will have more time and power to work on things that they are passionate about, rather than merely working for a living. Meanwhile, from ancient times, until now, it has been proven that people's lives are always better than they were in past revolutions. I believe this situation will remain the same with the new revolution posed by AI”.



Figure 5.14. WordCloud Map - Question 14.

5.3. FURTHER ANALYSES

To explore the question of whether there was any potential relationship between participants and demographic data, we conducted a further analysis of the interview comments and different groups of participants (i.e., occupation and gender). Similar to the interview response analysis in the previous section, we did word cloud interpretations for all 14 interview questions asked of different groups of participants. Then, we compared the word cloud maps of the different groups.

First, all participants were filtered by their current occupations, and regrouped as students and non-students. Also, we compared male and female participants.

5.3.1. Students and Non-Students Differences. The students who participated in this study are either working on an undergraduate degree, or a graduate degree at a higher educational institution. Participants who are non-students include professors, lecturers, or staff at Missouri S&T and those employed in industrial-based occupations in different companies, such as consultants, administrators, or managers.

5.3.1.1. Analysis of student responses. Responses to questions were found to be consistent between the two groups, except for Question 10: What should higher education do to address the impact of AI on the future of work and humanity? The responses from the student group are depicted in Figure 5.15.

As Figure 5.15 shows, SituationAwareness, TeachAI, LearnAI, TechnologyFocus, and AI focus are the most common concepts noted by all of the collected comments.

One comment on SituationAwareness was: “to make the students and the general public aware of the fact that AI would possibly bring out both positive and negative results. Humans should not only focus on the potential benefits that will come with AI, but also they should also have a decent knowledge of the negative. For instance, with the development of AI, more tasks that used to require human labor can now be easily done by AI, with less human error and better efficiency” (Subject 17). For this reason, some jobs are likely to be lost. This could become an issue as most of the people affected still need to work and make a living. Job loss would possibly lead to severe psychological problems and relevant social issues. However, if people are aware of such situations in

advance, they will have more time to prepare themselves for such situations and to build more connections with AI, at the same time.

TeachAI, LearnAI, AIFocus, TechnologyFocus were also mentioned in response to this question. Most participants believed that it is essential for higher education to switch its focus and to better address the impact of AI. Because the role of AI will become more critical in the future, the knowledge of AI should be a primary focus of higher education. Also, these educators need to assure that their students are able to gain sufficient knowledge of AI, both in breadth and in-depth, as needed. Teaching AI and having AI as a focus does not necessarily mean that all the students will need to know how to write code for AI. Instead, all students will need to be equipped with a basic understandings of AI--what AI is how it works; how it has evolved; and how to work in partnership with AI. As society becomes more technologically-based, the concept of technology and AI will become more imperative in our future world.

Also, AcceptAI and AdaptTheTrend were frequently mentioned by many collected responses. People will need to build connections with AI and accept AI more readily than they have today, in order to better adapt to the coming AI trend.

5.3.1.2. Analysis of non-student responses. Non-student participants responses are analyzed and are depicted in Figure 5.16.

Contrary to conclusions by the student group, fewer participants focused on teaching students about AI or related technical skills. PracticalSkills and AcceptAI were the most common keywords, indicating that the two-fold responses from our participants were from a skillset perspective and from a psychological perspective.

remain important and may even become more important in the future job market. The results of our study from the non-student groups were consistent with the results found from Börner (2018). The importance of soft skills should not be overlooked in the future job market. It should be regarded, at least as important as hard technical skills (or even more) to add to one's competitiveness when facing threats posed by AI.

5.3.1.3. Analysis of response differences. The differences between the responses by the student group and non-student group may be due to social status differences that exist between students and non-students. Belot (2015) found that students tended to have better strategic reasoning skills, than non-students, and students were not as pro-social as non-students. Also, Gächter (2004) concluded that students were less cooperative, as compared to non-students. These prior studies could explain the differences in focus reflected in the comments collected from the two groups. With better strategic reasoning skills, more comments, with a focus on building hard skills, were received from the student group when addressing AI's impact on future work and humanity. Non-students believed that accepting AI and enhancing soft skills were important, since non-students tended to be more pro-social than students did (Belot, 2015), and their views were more from a social and psychological aspect.

In addition, more non-students proposed the importance of practical skills. One possible explanation is that non-students had longer working experience and this experience made them recognize the importance of practical skills. As some of our participants said: "the skills in books are teachable, whereas the ability to make use of knowledge is hard to teach a person" (Subject 50).



Figure 5.16. WordCloud Map - Non-Students Response for Question 10.

5.3.2. Gender Differences. To have a better understanding of the collected data, we also compared interview responses by males and females. A study by Cahill (2006) indicated that gender impacted substantially on the cognitive functions of humans, especially for emotion, memory, and perception. Also, because of the differences between the gender-related structures within the brains, men and women tend to react differently, in terms of encoding memories, emotion sensibilities, facial recognition, problem solving critiques, and decision-making processes, as the brain is the main center that controls a human's cognition and behavior (Cosgrove et al., 2017).

However, despite the inevitable differences between different genders, no noticeable differences were found in the collected responses. Gender-based analyses of the responses for each question are similar to the analyses we did for the responses to each question by the participants.

6. LIMITATIONS AND FUTURE RESEARCH

Several limitations in this study can be better addressed in future research. First, the data collection was conducted in Rolla, Missouri, with a focus on the campus of Missouri University of Science and Technology (Missouri S&T). This may not be representative of results that would be obtained elsewhere. Also, Missouri S&T is a technology-driven university that focuses heavily on engineering and technology. The results may be different when less technology-based institutions are surveyed. However, this unique feature of our sample has provided special insights as the collected results come from people who are engaged in the cutting-edge of technology. Their perceptions can somewhat better address the potential impact of AI. For future research, we expect to collect more data from larger groups of people representing various backgrounds.

Second, the participants in this study were mostly students from Missouri S&T, which may not be representative of our society as a whole. For future research, we would like to collect more viewpoints from the administrative level in higher educational systems, as well as from other policy-makers in higher education.

Third, this study adopted the interview methodology, which requires face-to-face interviews of all participants. This is relatively intensive and time-consuming, as compared to other methodologies, and tends to constrain the sample size. Hence, other research methodologies can be employed in the future.

7. CONCLUSIONS

Higher education is being hit by a “perfect storm” in today’s world, and it needs to brace for impact! AI will probably be highly disruptive and truly transformational, as far as today’s society is concerned. Continuous reorganizations and curriculum changes will be necessary for institutions of higher education to stay relevant and “afloat” scholastically and financially. The gap between the focus of higher education and the needs of the market need to be bridged.

The needs of higher education and its students must be prepared and “robot-proof” to contend with the fast-pace of AI development. Its strategies must be updated to better address what industry and society require, rather than plodding along and doing business as usual. Also, more sophisticated content relating to AI and its applications has to be included in the curriculum of higher education. It has a primary responsibility to cultivate its students to become early adopters of AI, and to prepare its students to be innovative and successful in the AI age.

APPENDIX A.
SURVEY QUESTIONNAIRES

Part I. Demographic Questions

1. What is your age? (18-24, 25-34, 35-44, 45-54, 55 and above)
2. What best describe your gender? (Male, Female, Prefer not to say, Prefer to self-describe)
3. What is the highest degree or level of school you have completed? (if you are currently enrolled in school, please indicate the highest degree you have received)
(Less than a high school diploma, High school degree or equivalent, Some college, no degree, Associate degree, Bachelor's degree, Master's degree, Professional degree, Doctorate or higher)
4. What is your current occupation? (Undergraduate student, Master student, Ph.D. student, Faculty i. Rank, ii. Department; Administrator i. Position; Other i. Please specify)
5. If you are currently a student, what are the degree and major you are currently pursuing? _____
6. How much do you know about Artificial Intelligence? (Extremely Unknowledgeable, Quite Unknowledgeable, Slight Unknowledgeable, Neither Knowledgeable or Unknowledgeable, Slightly Knowledgeable, Quite Knowledgeable, Extremely Knowledgeable)

Part II. Survey – Relationship towards Technology

Table A.1. Survey Questionnaire

| Measured Items (Strongly Disagree, Disagree, Neither agree or disagree, Agree, Strongly Agree) | |
|--|---|
| Affinity for Technology | Technology is my friend. |
| | I enjoy learning new computer programs and hearing about new technologies. |
| | People expect me to know about technology and I don't want to let them down. |
| | If I am given an assignment that requires that I learn to use a new program or how to use a machine, I usually succeed. |
| | I relate well to technology and machines. |
| | I am comfortable learning new technology. |
| | I know how to deal with technological malfunctions or problems. |
| | Solving a technological problem seems like a fun challenge. |
| | I find most technology easy to learn. |
| | I feel as up-to-date on technology as my peers. |
| | I feel it is important to be able to find any information whenever I want online. |
| | I feel it is important to be able to access the Internet any time I want. |
| | I think it is important to keep up with the latest trends in technology. |
| Anxiety About Being Without Technology or Dependence on Technology | I get anxious when I don't have my cell phone. |
| | I get anxious when I don't have the Internet available to me. |
| | I am dependent on my technology. |

Table A.1. Survey Questionnaire (cont.)

| | |
|--------------------------------------|--|
| Positive Attitudes Toward Technology | Technology will provide solutions to many of our problems. |
| | With technology, anything is possible. |
| | I feel that I get more accomplished because of technology. |
| Negative Attitudes Toward Technology | New technology makes people waste too much time. (Reverse Coded) |
| | New technology makes life more complicated. (Reverse Coded) |
| | New technology makes people more isolated. (Reverse Coded) |

APPENDIX B.

INTERVIEW SURVEY QUESTIONNAIRE

Table B.1. Interview Questions

| | |
|--------------|---|
| Question 1. | What do you think AI is? |
| Question 2. | What do you expect AI to do in the future? |
| Question 3. | What is your view of AI taking over some jobs in the future? (Awareness of your job) |
| Question 4. | Are you concerned about AI taking over some jobs in the future? |
| Question 5. | Are you concerned about AI taking over your job in the future? |
| Question 6. | Do you think your job will be taken over by AI in the future? |
| Question 7. | How do you think the higher education will be impacted by AI? |
| Question 8. | What should higher education do to address the challenges pose by AI? |
| Question 9. | What are the changes necessary in higher education to address the challenges pose by AI? |
| Question 10. | What should higher education do to address the impact of AI on the future of work and humanity? |
| Question 11. | How can you prepare yourself for the future where AI is going to replace some jobs? |
| Question 12. | What is your opinion on the future of work (i.e. impact of AI on jobs, skills, and wages)? |
| Question 13. | What is your opinion on the future of humanity (i.e. will humans be better or worse because of AI)? |
| Question 14. | What is your opinion on the future of society (i.e. will society be better or worse because of AI)? |

APPENDIX C.
FURTHER ANALYSES

Table C.1. Students and Non-Students Differences.

| Question | Non-Student | Student |
|------------|---|---|
| Question 1 |  <p>Machine Learning Function Like Human Self Learning Learn From Data Make Better Life</p> |  <p>Function Like Human Humans Simulation Self Learning Improve Life Self Thinking Job Replacement New Trend</p> |
| Question 2 |  <p>Help With Work Job Replacement Improve Life High Level Job 4 Human</p> |  <p>Help With Work Job Replacement Take Low Level Job High Level Job 4 Human Strong AI Take Over Everything Automated System Make Better Life Cost Efficient</p> |
| Question 3 |  <p>Job Replacement Create New Jobs Human Involvement Take Low Level Job Better Skills</p> |  <p>Job Replacement Create New Jobs Inevitable Help With Work Take Low Level Job Cost Efficiency Retraining Program Better Skills Education Is Important High Level Job 4 Human Human Monitor</p> |

Table C.1. Students and Non-Students Differences. (cont.)

| | | |
|------------|--|---|
| Question 4 | <p>NotSure</p> <p>NotConcerned</p> <p>Concerned</p> | <p>NotConcerned</p> <p>Concerned</p> |
| Question 5 | <p>NotConcerned</p> <p>Concerned</p> | <p>Concerned</p> <p>NotConcerned</p> |
| Question 6 | <p>DoNotThinkSo</p> <p>Depends</p> <p>ThinkSo</p> | <p>DoNotThinkSo</p> <p>Depends</p> <p>ThinkSo</p> |
| Question 7 | <p>WorkWithAI</p> <p>GreatImpact</p> <p>LearnAI</p> <p>FocusChange</p> <p>LessImportant</p> | <p>HelpWithWork</p> <p>BetterSkills</p> <p>GreatImpact</p> <p>Renent</p> <p>AIFocus</p> <p>GetPrepared</p> <p>UpgradeSkills</p> <p>JobReplacement</p> <p>AIfocused</p> <p>LearnAI</p> <p>FocusChange</p> <p>WorkWithAI</p> <p>AIdepartment</p> <p>TeachAI</p> |
| Question 8 | <p>TechnologyFocus</p> <p>TeachAI</p> <p>ComplementAI</p> <p>TeachTechnology</p> | <p>DeliveryMethodChange</p> <p>SpecializedFocus</p> <p>TeachTechnology</p> <p>TechnologyFocus</p> <p>AcceptAI</p> <p>SituationalAwareness</p> <p>PracticalSkills</p> <p>RetrainingProgram</p> <p>HelpWithTeaching</p> <p>HelpWithWork</p> <p>WorkWithAI</p> <p>PrepareStudent</p> <p>HelpWithAI</p> <p>AdaptTheTrend</p> <p>AIdepartment</p> |

Table C.1. Students and Non-Students Differences. (cont.)

| | | |
|--------------------|--|--|
| <p>Question 9</p> | | |
| <p>Question 10</p> | | |
| <p>Question 11</p> | | |

Table C.1. Students and Non-Students Differences. (cont.)



| | | |
|--------------------|---|--|
| <p>Question 12</p> |  |  |
| <p>Question 13</p> | <p>Better <small>Worse</small> Depends</p> | <p>Worse <small>SameAsNow</small> Depends Better</p> |
| <p>Question 14</p> | <p>Depends Better <small>Worse</small></p> | <p>Worse <small>SameAsNow</small> Depends Better</p> |

Table C.2. Gender Differences.

| Question | Female | Male |
|------------|--------|------|
| Question 1 | | |
| Question 2 | | |
| Question 3 | | |

Table C.2. Gender Differences. (cont.)



| | | |
|------------|---|--|
| Question 4 | <p>NotConcerned^{NotSure} Concerned</p> | <p>NotConcerned^{NotSure} Concerned</p> |
| Question 5 | <p>NotConcerned Concerned Depends</p> | <p>NotConcerned^{NotSure} Concerned</p> |
| Question 6 | <p>ThinkSo DoNotThinkSo Depends</p> | <p>Depends ThinkSo DoNotThinkSo</p> |
| Question 7 |  |  |

Table C.2. Gender Differences. (cont.)

| | | |
|--------------------|--|--|
| <p>Question 8</p> | | |
| <p>Question 9</p> | | |
| <p>Question 10</p> | | |

Table C.2. Gender Differences. (cont.)

| | | |
|--------------------|--|---|
| <p>Question 11</p> | <p>Word cloud for Question 11 (Left) featuring terms like: Keep Learning, Learn Technology, Technical Skills, Adapt Changes, Adapt The Trend, Get Prepared, Learn AI, Learn More, Complement AI, and Adapt Change.</p> | <p>Word cloud for Question 11 (Right) featuring terms like: Keep Learning, Learn AI, Learn More, Technical Skills, Get Prepared, Adapt The Trend, Learn 2 Use AI, and Work With AI.</p> |
| <p>Question 12</p> | <p>Word cloud for Question 12 (Left) featuring terms like: Wage Increase, Technical Capability, Job Change, Human Control, Job Replacement, More Knowledge, Adapt The Trend, Accented, and Get Prepared.</p> | <p>Word cloud for Question 12 (Right) featuring terms like: Wage Increase, Technical Capability, Job Replacement, Human Interaction, UBI, Lower Wage, Take Low Level Job, Work With AI, and Get Prepared.</p> |
| <p>Question 13</p> | <p>Word cloud for Question 13 (Left) featuring terms: Depends (large blue), Worse (large red), and Better (large red).</p> | <p>Word cloud for Question 13 (Right) featuring terms: Depends (large blue), Better (large red), and Worse (large red).</p> |
| <p>Question 14</p> | <p>Word cloud for Question 14 (Left) featuring terms: Better (large red) and Depends (large blue).</p> | <p>Word cloud for Question 14 (Right) featuring terms: Better (large red) and Depends (large blue).</p> |

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