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Skilling the Gap: 21 Conversations on Designing Education for Those Left Behind as Robotics and Artificial Intelligence Advance

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Robotics and artificial intelligence (RAI) is advancing rapidly. These advances risk exacerbating inequalities unless the benefits are shared across society. Education in RAI is often aimed at business leaders and students. While education designed for these groups is needed, it is not accessible by everyone, and there is potential for people to be left behind. To understand the barriers in designing an educational scheme for those often missed by other initiatives, a pilot study was conducted. Twenty-one semi-structured interviews were held with Thought-Leaders, Industry, Adult Educators, and Members of the Public. A thematic analysis was used to allow themes not previously thought of to arise. Looking at the findings through the lens of leaving no one behind presents three themes, which need to be addressed for education to be successful. First, as well as education for those designing RAI and education for everyday life, there needs to be education for those working with RAI. Second, work is needed to overcome preconceptions. The views of learners on RAI, potential “gatekeeping” of experts, and attitudes to training from industry can create barriers to education. Finally, education should be co-designed with communities to ensure it is relevant to the learners’ needs and lives.

communities. Exploratory interviews with stakeholders were conducted to understand requirements for a successful educational initiative. Thought leaders in artificial intelligence (AI) were interviewed as their support is needed to promote, run, and fund such an educational initiative. Industry were interviewed to align educational needs to any potential future path-to-work opportunities. Adult educators were interviewed to understand the needs of adult learners and how such an education could be realized. Finally, and most importantly, members of the public were interviewed to understand their views on AI and training. The interviews were conducted with individuals, and companies based on the UK, the findings and discussions are, therefore, largely UK-centric. These interviews have revealed some areas, which need to be considered and addressed when designing education in RAI aimed at the general public. Throughout this work, the term education

1. Introduction


Robotics and Artificial Intelligence (RAI) is becoming increasingly common in both everyday and working life. Adult education will be central to this transformation and can be used to empower citizens to use technology to improve their lives and

will be used, as the aim of these interviews and the design stage is to create education, which works the best for the learners. As such, the type of education (this could be formal or non-formal, linked to business or community lead, and digital or in-person) should be dictated by the findings.

As has happened with previous technological advances, there is a risk that certain groups of the population will be left behind as RAI grows.^[1] Existing inequalities could be deepened if the benefits (and disadvantages) created by these technologies are not shared equally throughout society.^[2] Education is one method of minimizing the number of people being left behind. Often those at risk are the same people who could not or would not avail of other formal educational offerings, and whose employers would be unlikely to provide such education. Thus, any education must be specifically designed with these people and their needs in mind. This research aims to be the initial data used to inform further research and development of an educational initiative for those potentially left behind.^[3–5]

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1.1. Fourth Industrial Revolution

The advancement of emerging technologies, including RAI and related technologies, such as autonomous cars and the Internet of Things (IoT), is often referred to as “The Fourth

Industrial Revolution.” This phrase was coined in 2016 by Klaus Schwab, Founder and Executive Chairman of the World Economic Forum (WEF) and author of a book by the same name.^[2] The UK Government’s whitepaper on the Fourth Industrial Revolution^[6] lists four grand challenges, the first of which is AI and data technology. A further two of these grand challenges, *mobility* and *aging population*, are also heavily linked to RAI.

Examples of RAI (the definition of AI is a largely debated topic, and as this research focuses on the members of the public, the definition has been taken loosely and from their point of view. Thus, it includes examples, such as Voice Assistants and more general algorithms, which experts may not class as AI) are increasingly being seen in every aspect of modern life. Voice assistants, such as Siri, Google Assistant, and Alexa, are used in many phones and devices. Navigation devices or Sat Navs use complex algorithms to find the best routes based on several data sources, including Waze and Google Maps. Software claiming to use AI is used in many workplaces; for example, accounting software Auto Encoder reads bank statements and sorts transactions into categories required for tax calculations. Chatbots are now used in healthcare, including those by the NHS, Babylon Health, and Ada Health. Also, RAI technologies are often reported on in the media, including from companies such as Deepmind with their champion Go playing algorithm, AlphaGoZero.^[7] Moving toward the hardware side of things, robots are already used in manufacturing lines, warehouse logistics, surgery, and cleaning. Autonomous driving is featured prominently in research, startups, industry, and government strategies. Also, Boston Dynamics’ robots have been backflip-ping, opening doors, and inspiring episodes of Black Mirror.

1.2. Will Robots Take Our Jobs?

RAI is often depicted in the media, including the news and films, in extremes—either RAI will save or destroy us. Positive examples include reports of algorithms diagnosing patients better than doctors, robotics making factories and disaster sites safer, and RAI saving companies money. On the other hand, the narrative of “killer” robots and jobs being lost to RAI are common. Research into public perception of RAI has been carried out by institutions (such as the Royal Society^[8]), consultancies (such as KPMG^[2]), and academics.^[9,10] The research reports varying attitudes toward RAI found within the public. Some found more Americans were in support of AI,^[10] whereas another found 70% of US adults were “weary” of AI.^[11] One aspect raised in this study was the implications for jobs. This can be seen in other countries with one-third of Irish adults,^[12] and two-thirds of UK^[13] adults concerned RAI will replace their jobs in the future. KPMG found those who knew less about AI were more likely to worry about losing their jobs.^[2]

One of the most cited papers found that 47% of jobs in the US^[14] were at “high” risk of automation. When the same method was applied to the UK and Europe, 35% and 40–60% of jobs were at risk, respectively.^[15,16] Other reports from PwC^[17] have predicted three waves of job losses, resulting in an overall automation of 30% jobs. This report along with one from the ONS^[18] did see these job losses as being equally shared across society (both

agreed those with “low” levels of education would be most impacted). The WEF’s Future of Jobs^[19] report gave a slightly different angle, reporting 50% of businesses said they felt they would reduce their full-time workers or hours by 2022. However, 38% said increased technology and automation would increase their employment and productivity.

Rather than looking solely at jobs lost, some reports take a more holistic view of the overall impact on jobs. The OECD data note 14% of jobs are likely to be automated, but further to this, 35% of jobs are likely to change by 2030.^[20] The Centre for European Economic Research predicts an increase in overall jobs, but with these jobs being of a different nature, thus resulting in job losses for some.^[21] In 2018, McKinsey reported that up to 14% of workers worldwide (375 million people) will need to change jobs and reskill because of automation and AI by 2030.^[22]

Regardless of the net impact on the number of jobs, the Fourth Industrial Revolution will definitely have an impact on the future of work. This is likely to transpire in a number of ways: 1) Jobs will be lost due to automation. 2) Jobs will be created due to advances in RAI. 3) Jobs will change as tasks are automated, and more RAI systems are introduced.

The rise of these technologies is also creating jobs already. Facebook announced 1000 new jobs in the UK in 2020 due to their increased use of AI.^[23] The Royal Society reported a 231% increase in job postings requiring Data Science and Advanced Analytics skills.^[24] This increase in jobs requiring specific RAI and data skills has created a *Skills Gap* as there are not enough people with the necessary skills to fill these roles, which has impacts on businesses. According to the Open University Business Barometer, over 90% of businesses surveyed have not been able to find the talent needed, and 61% believe this has worsened in the past year. This skills gap is costing the companies £63 billion a year in additional recruitment, retraining, temporary staff, and higher offers.^[25] While adult education will not address the immediate need for RAI experts, the skills gap is predicted to increase as these technologies grow. Educating adults in such a way could increase demand for re-training initiatives becoming accessible by a greater proportion of the population, leading to a larger, more diverse RAI workforce.

1.3. Education to Overcome the Skills Gap

There have been many measures to overcome the Skills Gap. To illustrate who these measures may overlook, it is useful to look specifically at the UK, where the government has many initiatives to combat the digital skills gap (shown in **Figure 1**). This example is for illustrative purposes and not a complete example. Complex issues such as unequal access to education and unemployment have not been considered as they deserve more attention than this article can devote. They are, however, extremely important in ensuring no one is left behind.

Figure 1 shows the three typical stages of life—school, university (which is not compulsory), and work. The School curriculum is being addressed by the National Centre for Computing Excellence,^[26] which aims to ensure all children of school age receive the necessary computing school for the digital age. Several initiatives aimed at the University section will create a number of Industry-funded degrees, as well as extra funding

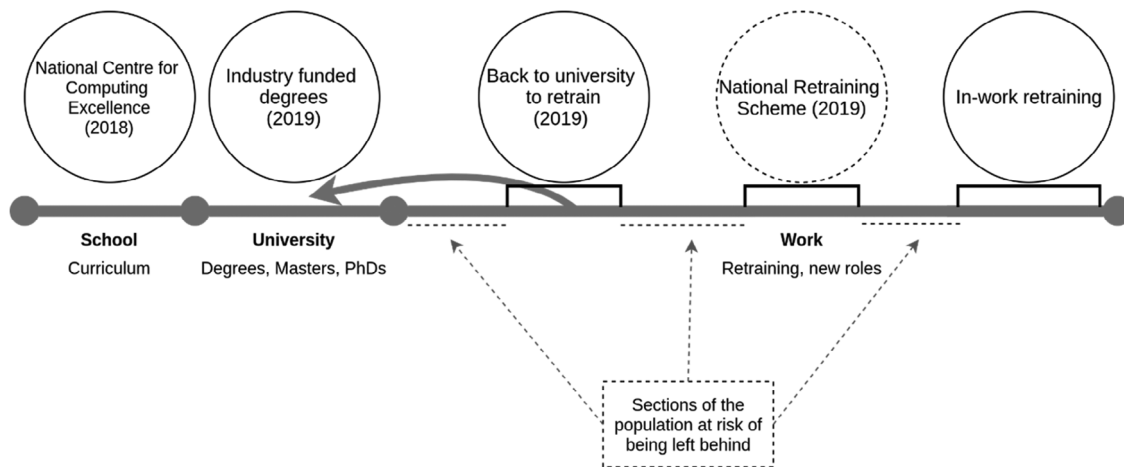


Figure 1. Government efforts to close the skills gap in the UK.

for Masters and Ph.D.s' in AI.^[3] A further scheme to help those in work retrain at university was also proposed in 2019.^[27] This scheme, which is a necessary step in creating more AI talent in the UK, has a degree requirement for participation, which creates a barrier to entry. Once in work, the reskilling options become more dependent on the employer. Many companies offer in-work training, including opportunities to undertake Apprenticeships and degrees while working. Others do not, and the responsibility and cost are passed to employees.

While these initiatives go a considerable way toward addressing the Skills Gap, there are still segments of the population, which may be left behind, as shown in the figure. This includes those who cannot, or do not want to, return to university to retrain and those who do not work for companies, which will provide the opportunity for in-work retraining. In an effort to close these gaps, the UK Government has created a National Retraining scheme.^[28] This scheme is not available to everyone and will provide support for those over 24, currently in work, without a University degree and earning below a certain yearly threshold.

1.4. RAI Education for Everyone

RAI education, as it exists today, is largely focused on students and business leaders. Large, multi-national companies are offering their employees retraining and opportunities to study toward relevant qualifications.^[29,30] In-work retraining has already been seen to be successful in a number of cases. One notable example is the Professional Services company Accenture, who, due to a large effort on reskilling, had no job losses when 17 000 jobs were automated.^[31]

There are a large number of new courses and funding for students wishing to study related topics at all levels of Higher Education.^[27] The AI index reports a 5-fold and 12-fold increase in enrollment for introductory AI and machine learning (ML) courses, respectively, at certain US Universities (from 2012 to 2018).^[32] Children have also been a focus of attention, with curriculums expanding to include coding accompanied by a rise in

the number of coding and RAI after-school and holiday clubs offered.^[8]

Courses offered on the internet have also provided greater reach for education on RAI as free courses, or Massive Online Open Courses (MOOCs) have become popular on this topic. These courses are offered by a number of platforms, such as Coursera, Udacity, and EdX, and include a range of free and paid for courses from World-Renowned Universities, such as Stanford, and technology companies, such as IBM. These courses also range from beginner to expert level and include Andrew Ng's *AI For Everyone*. While this course is an excellent starting point for a non-technical person wanting to learn about AI, it is geared toward business people who wish to learn about AI rather than the general public. "Tech Giants" also offer their own range of courses on AI, for example, Microsoft's AI School and Google Education's Google AI. While these courses are accessible and free, they are aimed at technologists and business people who wish to learn more about AI. A further online option to learn about AI is the competition website Kaggle.

These educational initiatives move toward closing the Skills Gap and provide opportunities for many people to learn about RAI (mostly AI). However, education is needed for everyone. Not everyone works for a company providing retraining or is in a position to return to further study (whether at a University or online). Online education is not without challenges—of particular concern are time and resources (both equipment and digital skills). Several of the studies into which jobs will be impacted suggest the very people who need education the most could be those who are missed (e.g., factory workers, retail staff, and call center workers). Rather than current educational offerings being modified to work for everyone, education needs to be designed specifically to target those people at greatest risk of being left behind.

An example of such an initiative aimed at the general public, focused on increasing knowledge of RAI, rather than the Skills Gap, is the online course *Elements of AI*. This course originally intended to educate 1% of the Finish population in the basics of AI, but is now working toward 5%, to ensure the electorate understandings of what they are voting for regarding AI.^[33,34]

The success of this course has resulted in Finish Government pledging to translate the course into all EU languages to educate 1% of the EU. While Finland can be seen as a trailblazer in terms of AI education, and their work can be built upon or used as frameworks in other countries, it is important to note that the Finland's approach to education cannot simply be replicated in other countries. Their attitudes to adult learning certainly differ from that of many other countries, with 76% of Finish adults already participating in formal adult learning.^[35,36]

While not suggesting they do not exist, it was not easy to find any readily available research papers, news articles, or websites for non-online RAI courses aimed at the general public. One example, although not of the general public, was efforts being made to teach prisoners in Finland about AI.^[37] This highlights the need for such an education to be created.

2. Methodology

The aim of this research is to better understand attitudes toward RAI, particularly around retraining for those at greatest risk of being left behind as these technologies advance. Recognizing the different viewpoints and concerns from a range of stakeholders (Thought-Leaders, Industry, Adult Educators, and Members of Public) will provide much needed insight to better inform the future design and delivery of any tailor-made educational initiatives.

To meet this aim, a quantitative method would not be appropriate. This research is not testing a hypothesis or attempting to find statistical relationships or patterns in the data. The aim is to explore perceptions, thoughts, and opinions of the four groups of stakeholders surrounding RAI and retraining of those potentially left behind. In seeking to discover potential barriers to participation in education, for those potentially left behind, unforeseen, subtle issues may emerge. These may be personal and unexplored, making them unlikely to come through in quantitative research.

Within social sciences and education, robust qualitative research methods have been long established.^[4,38] These methods advocate for qualitative, over quantitative methods, when seeking a deeper understanding of the how and why of a societal issue or individual perspectives and opinions. Due to the context specific nature of these methods, there are limitations to apply the findings of qualitative research beyond the particular setting, places, and spaces. As such, the findings of this research are not meant to be generalizable, but aim to add depth to the discussion on RAI education for the general public. Even with these limitations, a qualitative research methodology was the most appropriate with exploratory interviews, specifically semi-structured interviews, being used for data gathering.^[4,39]

Using semi-structured interviews, where a number of pre-defined questions guide the interviews, allows interviewees to elaborate or steer the conversation toward topics, which are important to them. This allows unforeseen issues to arise and be discussed, whereas the conversation remains largely focused on the research topics. Thus, semi-structured interviews find a nice balance between the rigid, often restrictive format of a structured interview and the often inefficient nature of an unstructured approach.^[4,40]

There are no hard and fast rules to determine the appropriate sample size for qualitative research, as discussed by Braun and Clarke.^[41] In social sciences, "there are no rules for sample size."^[42] Commonly, 15–30 interviews are used when the aim of the research is to identify patterns across the data generated.^[43,44]

The target number of interviews for each of the four groups of stakeholders was five interviews. This target was met in three out of the four groups, where the numbers exceeded five. In the Industry group, five was not met. The number of interviews per group was: 1) Thought-Leaders: six, 2) Industry: two, 3) Adult Educators: seven, and 4) Members of the Public: six.

The Thought-Leaders and Adult Educators were recruited through contacts—either directly or indirectly (i.e., introduced by a colleague at the same companies who were deemed more suitable to interview). All asked in these two categories were interviewed. Members of the Public were recruited and interviewed at a community event. Potential industry interviewees were contacted through connections (both personal and those formed at conferences) and posts on social media. Companies with workers who were likely to be impacted by AI in near future (for example, retail, warehousing, and delivery) were targeted for these interviews. Twelve companies in these industries were contacted regarding interviews—nine responded, and five interviews were agreed to or arranged, although only two actually materialized. There was interest in this topic, but often finding someone who could discuss the company's plans for training and automation, or concern about how answers would reflect on the company, prevented interviews.

The interviews were not recorded, but notes were taken by hand. Recording would have prevented several interviewees participating or speaking freely. This was considered of particular importance for the Members of the Public group where the interviewees were already arguably talking about unfamiliar ideas, perhaps outside their comfort zone. This was important in ensuring we hear from them, as they are often the voice that is not included in education and RAI discussions.

The data from these interviews were analyzed using qualitative techniques of initial coding and categorizing to draw out emergent themes, both within and across groups.^[5,38,45] These themes are presented in the Findings and explored through the lens of leaving no one behind in the Discussion. As the Members of Public are often missed from such discussions, their interviews have been placed at the beginning of the Findings to signify their importance.

3. Findings

Everyone interviewed knew about AI, and were keen to discuss (including those who stated upfront, they did not like AI). The conversations were diverse and interesting, providing an insight into attitudes on AI.

When discussing AI, the interviewees used several terms: 1) Artificial Intelligence or AI. 2) Machine Learning or ML. 3) Data Science.

The Members of Public (MoPs), and the Adult Educations and Thought-Leaders who work with them, used the term AI freely. These interviewees did not mention ML or Data Science. This

supports The Royal Society Report,^[8] which found only 9% of people had heard of the term ML. Interviewees from the other three groups with any form of technical training, or technical interest, used the phrase ML. Some interviewees stated that this was due to their skepticism that current technologies are actually AI.

“if it’s ML it’s Python, if it’s AI it’s in PowerPoint. It’s a buzzword” (the quotes included are the interviewees own words and have not been amended to modify grammar)

“it is a term that can encompass a lot of things, but most people mean Machine Learning”

“is a very general word. I think about Machine Learning or ML”

The term used by those considering AI from a business perspective tended to be Data Science. One Thought-Leader described Data Science as “statistics, modeling to enhance and accelerate human knowledge.” The term Data Science was used by Thought-Leaders and Adult Educators.

3.1. Members of Public

The members of public (MoPs) who were interviewed were vastly different in age (while the ages of interviewees were not explicitly asked, two interviewees gave their ages throughout their interviews as “nearly 20” and 78. It has been assumed all other interviewees fall within this age range), and had a variety of jobs (including warehouse worker, retired engineer, teacher, social media manager, childminder trainer, and first-aider).

3.1.1. Have You Heard of AI?

All but one MoP knew what AI was when asked and was able to give a definition. The person who was unable to give a definition when asked nodded at the definition of AI given by the interviewer. The interviewee was able to answer subsequent questions demonstrating the understanding of the concept. Thus, it could be reasoned not knowing the terms AI could be due to a language barrier.

3.1.2. Definition of AI

All definitions included the word “computer” or “robot,” and most included an example.

“It is using robots to Hoover or build a car.”

“It is computer based and relies on databases that aren’t up to date so is suspect. Used in laptops, flight controls.”

“It is robots that will do things for us and make us lazier.”

“It is...[pause]... computers learning from themselves such as the IBM... [Watson]”

“It is computers controlling everything—work, rest, and play. It is used in medicine.”

All of these definitions, bar one, include an example, and all include a more complex example than “everyday AI,” such as voice assistants or recommender systems.

3.1.3. Examples of AI

When asked to give examples of AI, only one person gave a “voice assistant” as an example of AI without the example being raised by the interviewer. All MoPs had heard of or used voice assistants and recommender systems when prompted.

“Of course, I have used those. Everybody uses Netflix and Amazon.”

When discussing AI, the MoPs mentioned nearly 40 examples of AI in total. These examples are shown in **Figure 2**. The majority of them occurred when asked a specific question (e.g., “Can you give me examples of AI?”); however, some examples came up naturally in conversation when they were answering other questions. The examples in response to another question are denoted by a dashed outline in Figure 2. Only one MoP did not bring up any examples in response to other questions. A large number of the examples, which came up naturally (i.e., not in response to the specific question on examples), were in response to the question around issues with AI. These “unprompted” examples were about translation, hoovers, Siri, and Aviation.

“We need to be careful. This technology doesn’t always work. A very famous example of translation. There was a translation of English to Russian “out of sight out of mind.” When translated from English to Russian and back, it was “invisible idiot.”

“I often talk about Siri taking over the world with my kids. Everyone is giving away so much data, which makes AI more intelligent and powerful. Eventually, we will not need to leave the house or do anything—shopping will be delivered, talk to everyone via messages, and VR for holidays.”

“Those little Hoover things move around your whole house. They could be mapping the size of your house and selling this to someone.”

“I heard of a story where a plane was grounded because of the AI on board... It due to simulations not working properly. They were showing something the pilot knew to be wrong. AI use can cause issues.”

The stories told about translation and aviation were identified as being something the individuals had heard from another source (for example, the news). Other examples also identified as having been heard from another source included those about a robot dog, spying satellites, and IBM Watson.

“I saw in the news that Japan has a Robot Dog. But, it’s not like having a real dog.”

“Things in films, that are not real, but not far off and actually out there. [interviewer: “such as?”] like spying

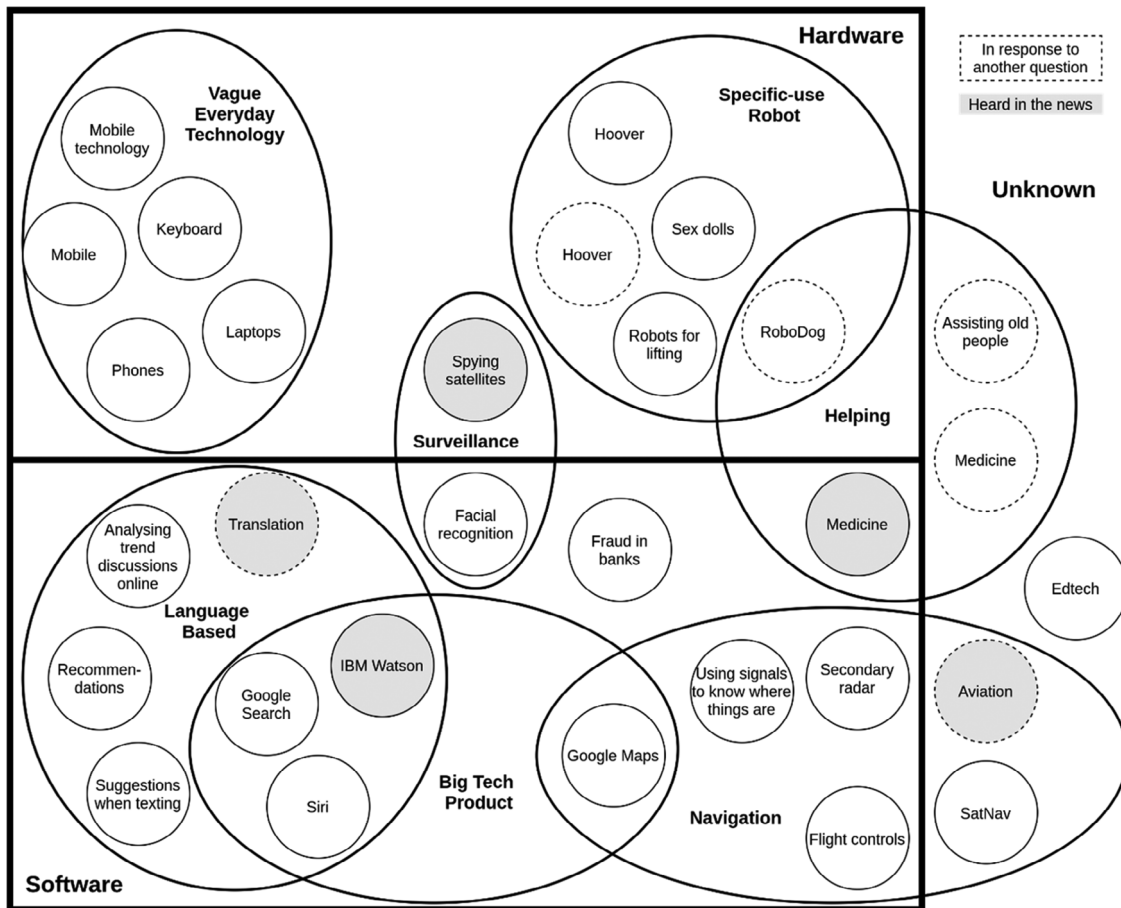


Figure 2. Examples of AI given by members of the public.

satellites, which are good for looking at people doing bad things but don't like this Big Brother style nation."

"It is [pause] computers learning from themselves such as the IBM ... [long pause] [interviewer: "Watson?"]. Yes, the question AI. I would have said Willis or something."

These *heard in the news* examples are shown as gray circles in Figure 2. In the majority of these examples, the individual did not seem confident of the details and could not answer any follow up questions, with the exception of the translation example.

The examples could also be defined based on whether they were hardware, software, or unknown. Several examples were unknown as they described a use-case or a large subset of technology, which could be either hardware or software, e.g., "old people," "in hospital," and "Edtech." The rest of the examples were almost evenly divided into software ("recommendation," "translation," and "Siri") and hardware ("robots for lifting," "hoover," and "keyboards"). This split is shown with the rectangles in Figure 2.

The examples can be further categorized based on "type" of AI and uses. These categories are shown in Figure 2 by the large circles grouping together examples. The categories (in descending size order) are as follows.

- 1) **Language-Based**—examples, which use either text or speech-based interactions and involve analyzing language to give results. This was the largest category, made up of all software examples. One example of *Language-Based* AI given was "suggestions when texting."
- 2) **Navigation**—examples, which involved giving directions, guiding, or another aspect of safely navigating individuals, cars, robots, or planes. The range within this category was large—from "SatNav" to "secondary radar," and included both software and unknown examples.
- 3) **Big Tech Product**—examples, which included one of the "Big Tech" companies. All of these were specifically about a product from one of these companies, e.g., "Google Maps," and were all software.
- 4) **Specific-Use Robot**—examples describing a physical robot used for an explicit reason, e.g., "hoover." All examples were hardware.
- 5) **Vague Everyday Tech**—some examples were of a simple ubiquitous device, e.g., "mobile." All examples were hardware.
- 6) **Helping**—some examples were explicitly designed to help people, e.g., "medicine." This was the only category, which spanned hardware, software, and unknown.
- 7) **Surveillance**—examples, which could be used to observe or monitor the public. These included hardware and software examples. Some examples, e.g., "Robot Dog," come under two categories (Specific-Use Robot and Helping). All of the Big Tech Products come

under another category to describe their use; e.g., “Google Maps” has been categorized at Navigation. Some other examples did not fit under any of these categories, e.g., “Edtech” and “fraud in banks.”

3.1.4. Impact on Jobs

The MoPs were asked about their jobs (current or past if retired), including the tasks they carry/carried out in their roles. They were further asked if they could think of any uses for AI in their job. Their responses are recorded in **Table 1**. All MoPs gave examples of how AI could be used in their jobs, including “Edtech” from a teacher and “secondary radar” from an engineer. Most readily gave examples without any prompting. Others had to be reminded to think of the tasks they performed in their job, or being given one example and asked for others. A number of the MoPs were positive about these uses.

“I have actually been thinking about this recently”

“I can see AI used in teaching”

Not everyone gave positive responses. One MoP explicitly stated it was why they left engineering. Another described themselves as “not an adopter of technology.” However, after thinking about the potential uses, they concluded they were “curious” about AI being used in their job. One other MoP was extremely neutral and matter of fact when describing uses in their job. Their neutrality could be due to them being retired from their job.

3.1.5. Concerns about AI

MoPs were specifically asked if they had any concerns. Concerns were also expressed throughout the interviews in response to other questions. One individual did not raise any concerns about AI, and one other had nothing positive to say about AI. All others gave a somewhat balanced view, with some coming off slightly more positive or negative overall.

The concerns expressed by the MoPs could be grouped together into themes: 1) Data Privacy and Control. 2) Does Not Work. 3) Negative Societal Impacts. 4) Laziness. 5) Data Quality. 6) Power Source.

The size and depth of these themes are shown in **Figure 3**.

All MoPs, who expressed concerns, brought up worries about the data being used in AI. These could be divided into two themes—*Privacy and Control* and *Quality*. *Privacy and Control* was mentioned by all these MoPs, sometimes more than once in the same interview. This theme was the largest in terms of number of references throughout all of the interviews. The MoPs mentioned their concerns about the amount of data being collected.

“Everyone is giving away so much data...”

“Sometimes, I’m not very happy with the amount of data and lack of control.”

The previous quote mentions “lack of control” with regards to their data. Other MoPs also brought up concerns about who owns or controls their data.

“The challenge is ownership of data and what can be done with it... Privacy is the big issue.”

“The big challenge is the lack of control...”

The MoPs also mentioned privacy concerns about specific technology such as “spying satellites” and “those little Hoover things that move around your whole house.”

The next largest category in terms of how many times it was raised in the interviews was *Negative Societal Impacts*. The main concern in this theme was the impact on jobs and potential unemployment.

“It could cause unemployment.”

“Could do someone out of a job.”

One MoP was “concerned about people being left behind,” and another worried AI (and other online activities) “takes the human element out of a very human activity.”

The *Quality* of the data used was mentioned twice, by two MoPs who had previously worked as engineers.

“Relies on databases that aren’t up to date so is suspect.”

“Good data is also a problem. For this, you need cooperation.”

These MoPs also both mentioned examples of AI not working correctly (the examples of failed translation and aviation

Table 1. Responses to AI impacting each member of public’s job.

Job	Prompted?	Uses	+ve/–ve
Engineer (retired)	N	“Secondary radar” and “SatNav”	Neutral—extremely matter of fact
Teacher	N	“Edtech, phones, and tablets”	+ve
Trainer	Y—Not an adopter of tech	“For those who like online training”	–ve But curious
Works in a warehouse	Y—Did not seem to consider hardware as AI	“Robots for lifting, or using signals to know where things are.”	+ve
Social Media Manager	N—Had actually been thinking about it	“Analyzing trend discussion online”	+ve
Ex-Engineer	N—It was why he left engineering	“Aviation”	–ve
Current first aider			

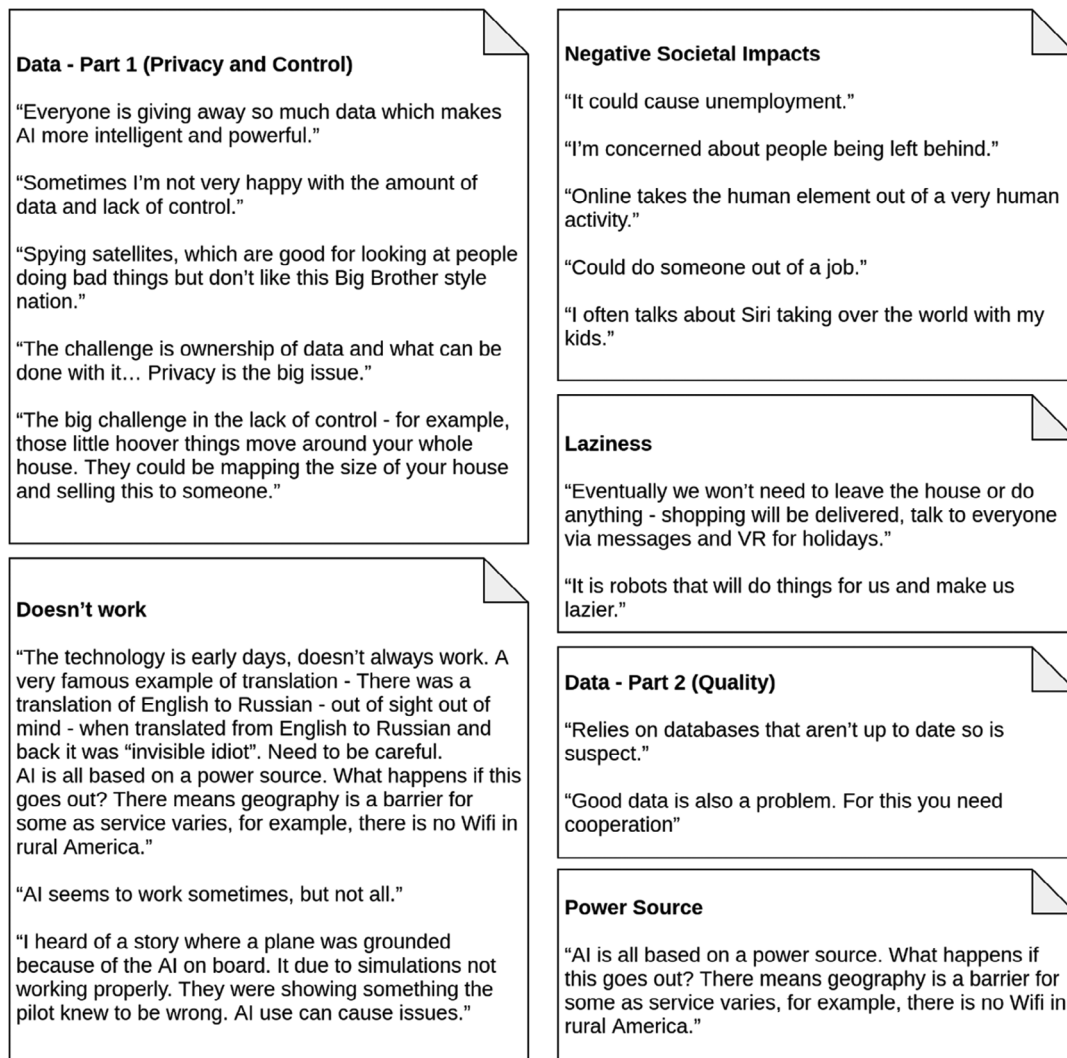


Figure 3. Concerns about AI given by members of the public.

discussed in the **Examples of AI** subsection). The issue of power sources for AI was also brought up by one of the engineers.

"AI is all based on a power source. What happens if this goes out? This means geography is a barrier for some as service varies; for example, there is no Wi-Fi in rural America."

One MoP, who self-identified as skeptical but was very well informed about the topic, was concerned with how well AI worked.

"AI seems to work sometimes, but not all."

They were also the only MoP to mention laziness, and they brought it up twice.

"Eventually, we won't need to leave the house or do anything—shopping will be delivered, talk to everyone via messages, and VR for holidays."

"It is robots that will do things for us and make us lazier."

The same MoP expressed concern about AI, specifically Siri, "taking over the world" albeit in a slightly joking manner, which was considered a *Negative Societal Impact*.

3.1.6. Optimism Regarding AI

As well as concerns, MoPs were specifically asked about the benefits of AI. Similar to concerns, positive views and optimism regarding AI were also expressed throughout the interviews not just in response to the question. The breakdown of optimistic views expressed by interviewee is shown in **Figure 4**. Most of the MoPs expressed optimism toward AI more than once during the interviews (a, b, c, and f). The social media manager, whose job is largely digital and seemed actively interested in AI, gave the highest number of optimistic statements (b). AI being "useful" was mentioned a number of times.

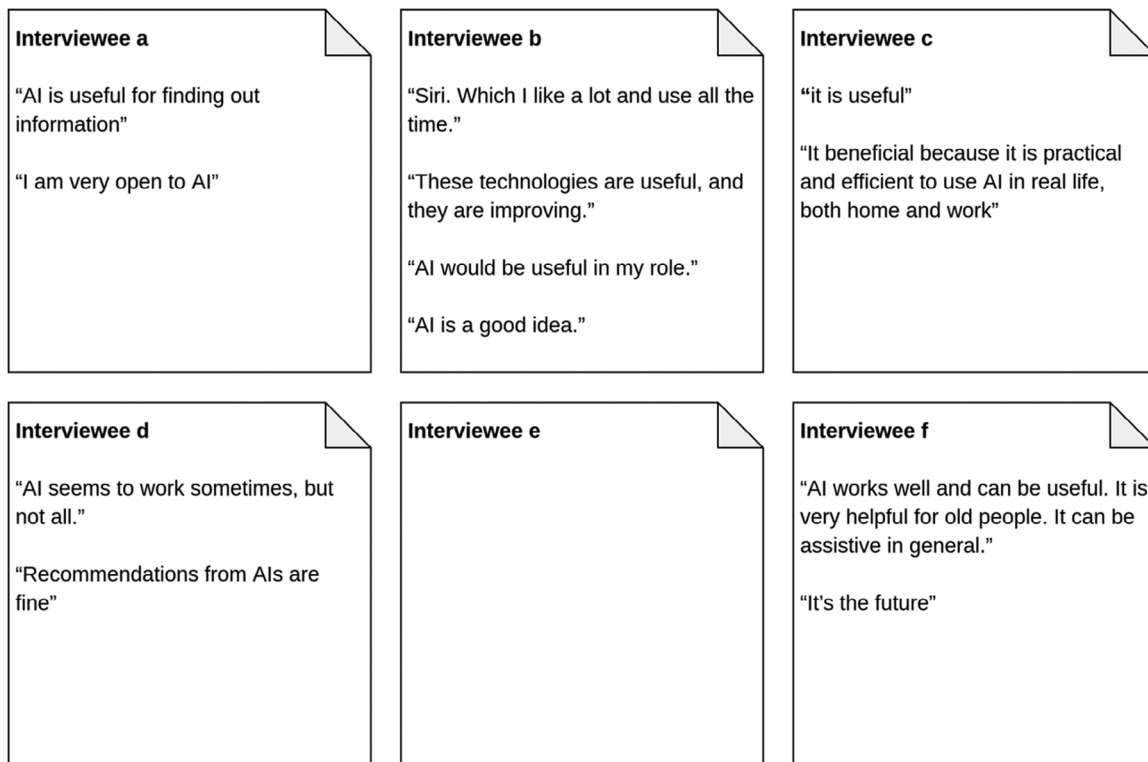


Figure 4. Optimism regarding AI given by members of the public.

“AI is useful for finding out information”

“It is useful”

“It is beneficial because it is practical and efficient to use AI in real life, both home and work”

“AI works well and can be useful. It is very helpful for old people. It can be assistive in general.”

“These technologies are useful, and they are improving.”

“AI would be useful in my role.”

Other optimistic comments on AI included it being “a good idea,” “the future,” and an MoP being “very open to AI.” One MoP was positive about a specific technology, Siri.

“Siri. Which I like a lot and use all the time.”

On the other hand, one MoP gave two marginally positive statements (d).

“AI seems to work sometimes, but not all.”

“Recommendations from AIs are fine”

One gave no positive statements throughout the whole interview (e). Both these MoPs identified themselves as skeptics and came across as very well informed, albeit negative, throughout their interviews.

Comparing Figure 3 and 4 shows that the number of negative statements expressed was greater than the number of positive.

This was despite both concerns and benefits of AI being asked as questions.

3.1.7. AI Training

To understand the demand or resistance toward AI training, the MoPs were asked if they would be interested in AI training. They were further questioned on particular types of AI training, including for work or home, understanding AI, or building AI.

One MoP did not respond to whether they would like AI training or not, and this may be due to them missing the AI part of the question and responding only with their views on training in general.

“I’m training as a carer. It is important to keep learning, especially as you get older, but in line with your interests. This is key!”

Only one MoP was positive and interested from the beginning. They would be interested in training both in general and if the technology was introduced in their job. They were enthusiastic about training on AI “because it is the future.” The other MoPs all originally said they would not be interested in training.

“No, definitely not.”

“No.”

“No to training. I’m not into training in general, and I read online when I need to know things.”

“How will it benefit me? Do I look like an academic? Such training is only for experts, given by experts. That is how they want it.”

However, either due to them reconsidering for themselves or further questioning, they all changed their mind and said they would be interested in particular training relevant to their lives.

“Yes actually I’d like to understand how it works and how to build something, but not how to use AI and I definitely wouldn’t use what I build.”

“Actually, I would be interested in training, particularly to make things more efficient for either work or home life... I would like to know how to use and how to build things.”

“Actually training to understand how AI works would be useful.”

“Tell you what I would be interested in, training around awareness of the implication and downsides. The news only shows the good side of AI, never shows the bad side. However society prides itself on keeping people ignorant, so why would that kind of training exist? It’s not what they want.”

When asked whether they thought this type of training already existed, none of the MoPs responded positively. One thought it existed but not easily accessible, and another thought it would only be for experts.

“I don’t think this type of training is available.”

“I don’t think this AI training exists.”

“I think the training exists—but it is only for experts or scientists. I should be interested in the general public getting training.”

“I think training like this may be available, but not easily accessible.”

3.1.8. Final Thought

When asked whether they had anything else to add, one MoP responded with a number of important points, which should be addressed by industry, academia, and government if AI is to successfully work for everyone. Concerns were about diversity and culture, particularly the focus on white, euro-centric, and middle-class points of view. Their comments also raised the issue of trust in academia, and the need for wider participation to ensure it represents everyone in society.

“I’m interested in diversity. Universities, AI, engineering. There is a white, euro-centric, middle class focus to everything. There is a culture dimension not being addressed. Need more diversity to make sure these things work for everyone. Good data is also a problem. For this you need cooperation [interviewer: what do you mean?] Like in this study, why would I be honest if this doesn’t have my interests at heart? AI fails on balance

of culture and class. There is not wide enough participation. Good luck on PhD from your very comfortable position of privilege.”

3.2. Industry

Both companies interviewed are household names in the UK (and potentially further afield), with yearly turnover greater than 1 billion pounds. They are both online retailers but in different industries. Both consider themselves technology companies, and both are thought of as technology leaders in their industries. In one company, the interview was with the General Manager of Warehousing, and in the other the Head of Engineering and Automation in Warehousing. Both mentioned they were speaking candidly about their own opinions and teams, and what they said did not necessarily represent the company view.

3.2.1. Use of AI in Their Company

Both companies said AI is being used in their companies, with more of a focus on the website and customer data than their respective warehouses.

“It is used extensively. Used throughout systems—such as modeling customer behavior or optimization of processes.” (Company 1)

“It is being used on a smaller scale than it will be in the future 12 months. It is being used more on the website, using customer data than in the warehouse, where it is in its infancy.” (Company 2)

Company 2 went into more detail of how AI is being used in their warehouses to predict what items will be ordered next.

“The order buffer system. Have you seen Monster’s Inc? It is like the hanging door system but with hanging bags. Based on historical data, we may believe an item is going to be ordered. For example, if a stripy t-shirt is selling well, it would be useful for it to be at the front.” (Company 2)

To understand the use of AI in these companies, they were asked why AI was being used. In both companies, AI was being used to improve the customer experience. Company 1 said it was used where humans could not give insights as the data were so large. Company 2 said reducing human interaction would improve the customer experience.

“... to optimize and make more efficient. Give better recommendations. Gain insights into large amounts of data, where humans cannot. Due to the large volume or intricacy of the data.” (Company 1)

“To take away the human element. If the system can predict actions before they happen, there are less touches and less cost, less time. It is about giving the customer the best experience.” (Company 2)

This is where the similarities in answers ended. The themes covered in these interviews are shown in **Figure 5**, which demonstrates the similarities and differences between the two companies.

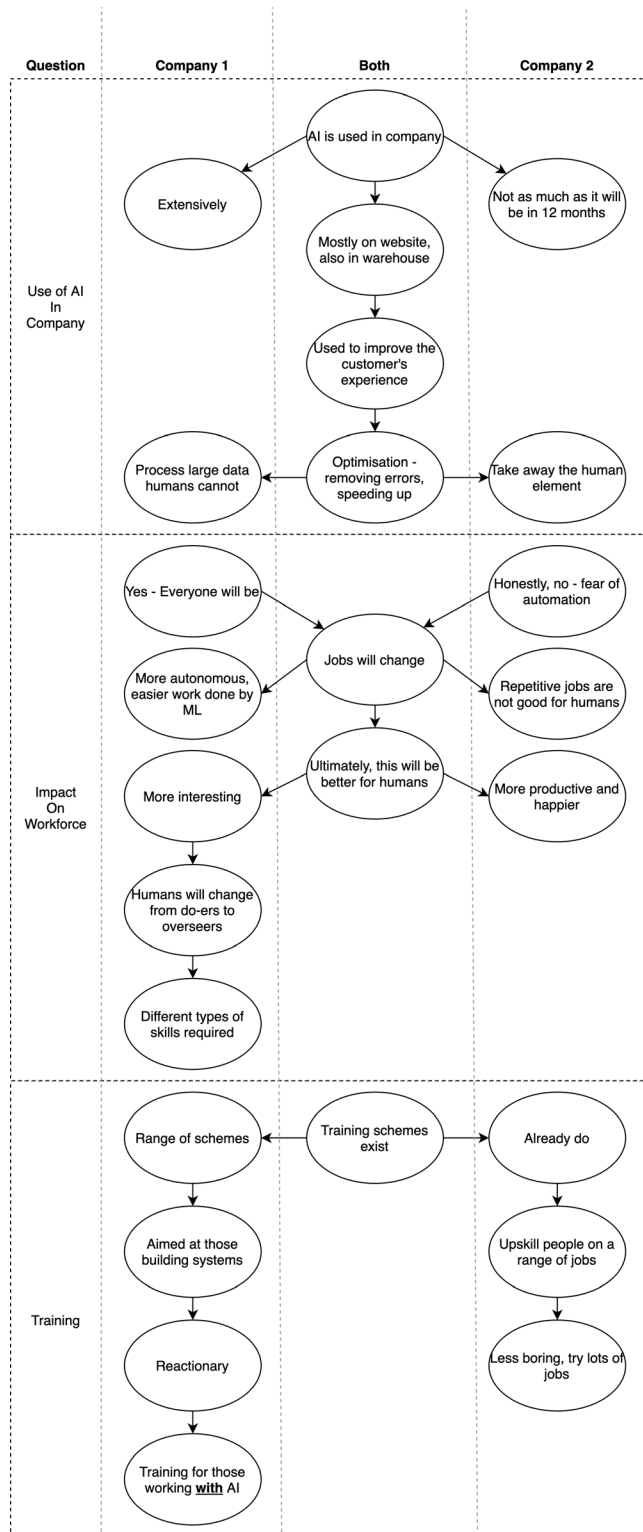


Figure 5. Comparison of two interviews with Industry.

3.2.2. Impact of AI on Their Company

The impact of AI on their workforce had polar opposite initial responses, with Company 1 saying everyone would be impacted, and Company 2 saying they did not think there would be an impact.

“Yes—everyone will be impacted by AI.” (Company 1)

“Honestly, no. Fear of automation, in general, are horror stories.” (Company 2)

Both companies continued and softened on their initial stance. Company 1 discussed how things will change, but this will be a good thing as it will result in more interesting careers requiring new skills. The change from people “do-ers” to “overseers” was touched upon in interviews with Thought-Leaders and Adult Educators as well.

“Roles will change, and they will become more autonomous. I want to say easier, but I actually think ML will do the easier stuff. People will end up with more interesting careers. People are currently the do-ers, and they will be overseers. It will require a different type of skill.” (Company 1)

Along a similar vein, Company 2 went on to say that repetitive jobs will be not be for humans anymore. They viewed this as a good thing, which will result in a happier, more productive workforce.

“Repetitive jobs that are not good for humans will be reassigned... People will be more productive and happier.” (Company 2)

3.2.3. Training

Industry interviewees were also asked about current and future training plans. Both offer a range of training for their employees. Company 1 said these schemes were for those who would be building AI systems (rather than working with them) and for their executives. They also described their attitude to training as “reactionary,” meaning they did not plan for advances rather responded to them.

“We have a range of schemes, but they are focused on training people who build systems to optimize. At the executive level, we have a lot of training. Operator training is in its infancy... this is reactionary.” (Company 1)

Company 2 had a different approach. They currently train their warehouse staff in multiple roles and in a number of tasks. This means workers have a more varied role, and as tasks are automated, there is less chance of jobs being replaced.

“We do anyway. We train people on multiple roles and tasks, and we upskill people. It is less boring, and it means they are tried on lots of jobs.” (Company 2)

The interview with Company 1 touched on training throughout. One point that was raised, with “picking robots” as the context, was the need for courses for those working with robots rather than building the systems.

“There are lots of courses in coding, programming, etc., but not in working with robots or AI. For people who don’t need to build, but you need to work with them... courses on how to use AI and robotics as a collaborator, rather than a builder.” (Company 1)

The interviewee further went on to say that if such training courses do not exist, and then, it is understandable that people in certain roles (where they may have to work with or may be replaced by AI or robotics) are more worried. These courses, the interviewee added, need to be general—about available careers and about a new way of working.

“If almost no training courses are non-developer training course, then it makes sense that people in these areas are worried. We need to develop some general courses about the career paths available. We also need to shift people from one way of working to another.” (Company 1)

3.2.4. Final Thought

While the interviews revealed very different stances on RAI and surrounding issues, both were extremely knowledgeable and interested in the topic, and both offered further interviews or testing a potential educational course.

“Interesting topic. Contact me if you need a second chat” (Company 2)

“If in your research you come across or create any course, I would want to know and would be happy to do a fitness test” (Company 1)

3.3. Thought-Leaders

3.3.1. Is it AI?

A theme, which came up throughout the conversations with Thought-Leaders, was whether what we were discussing really counted as AI and what was defined as AI rather than ML or Data Science. One Thought-Leader used the term “data driven technology,” which covered more than just AI, as discussions on this topic often include concepts not actually considered AI.

“We use the term data-driven technology rather than just AI. As pure AI is far off. But, decision-based services, such as logistic regression, are already being used, and we need to account for that. So, it is to include up to and including AI.”

This view was shared by another who saw AI as the future goal for Data Science.

“For me, AI is the end product of Data Science.”

Others thought the term AI was too general, and that ML should be used instead.

“AI is a very general word. I think about ML—it is automation, lots of numbers...”

3.3.2. Social Challenges

Thought-Leaders were specifically asked about the challenges, which need to be considered when designing an educational scheme on AI aimed at the general public. A lot of the challenges brought up were to do with social issues faced by members of the general public.

Demographics: The most common theme raised by this question was the differences in demographics. The sentiment of the target demographic changing the challenges was expressed by several Thought-Leaders. The different questions included young people versus adults, age, job, and whether or not they were still in formal education.

“Well, my first question would be are you thinking about young people or adults?”

“Depends on the people—age, job, like have they worked in a factory; 40 is harder than 20.”

“Training a 20 year old student is easy. Takes more time to train people who have other things going on.”

“I’m just checking it’s not individuals in further education, higher education or apprenticeships?”

One Thought-Leader discussed research already carried out regarding attitudes to AI from different demographics.

“There is research around different demographics and their knowledge about AI.”

Barriers: Another challenge raised was barriers to physically attend such an educational scheme. They included time, working (i.e., getting time off to attend), and not having a computer or the internet. Barriers, such as social mobility, affluence, and not being in education, were also brought up.

“If you have part time jobs, it might be hard to attend. To attend training courses, you need time and affluence.”

“Also, need to consider the barriers to retraining. People cannot just take time off work to retrain.”

“Everything is aimed toward those with computers and the internet.”

“I think the main problem is affluence and social mobility if people not in education or apprenticeship to have the chance to learn about tech.”

Lifelong Learning: The issue of people being out of education was discussed in more detail with regards to lifelong learning. One Thought-Leader explained that education is front-loaded; thus, it would be difficult to return to education, but that lifelong learning does exist in particular careers such as doctors due to their professional development. Another suggested thinking about what lifelong learning is, and speaking to companies who do this.

“Not AI specific, but there is a long tradition of front loading education—school, uni, done. My parents are doctors and must do learning throughout their

careers as part of their professional development as it's required. So lifelong learning exists in niches. So returning to education is difficult."

"You should be thinking about what is lifelong education? ... Have you thought about talking to companies who do lifelong education?"

"Think about this like lifelong learning."

Understanding/Language: Several of the Thought-Leaders mentioned the issues around understanding, language, and examples. Specifically, that the language is "over-technical in AI," and there are "no real examples." They further went on to say there is a "need to use realistic language" when discussing AI. One Thought-Leader gave a detailed example of issues that occur when common language and examples are not easily accessible.

"A basic example, we did some research with [a charity working with older people] patients where the youngest person was 65 and all ages upwards. We were very underprepared as this is conceptual. Unless people can touch or play with it, it was hard to have a meaningful conversation without leading them. There are groups of people, for example old people but others who don't even know what Siri is. We eventually got them to understand because one mentioned these old house wives books which everyone had and they had step by step instructions of how to treat a sick child. We were able to communicate using these as examples."

Attitudes to AI: The need to change "the narrative around AI," or "clear the air about AI," by explaining "what it can do and can't do" was discussed a number of times. The reasons for this were often cited as the media who "overhype" AI and are "obsessed with tech bros."

"oversell/hype about the patterns found"

"over-hyped media"

"We are often told bad points"

One Thought-Leader thought changing people's perceptions would be difficult, but needed.

"There is a need for general knowledge about setting the scene. It will be hard changing people's mind about what AI can actually do."

The Thought-Leaders expressed a perceived lack of interest from the general public in learning about AI, which needs to be addressed.

"Making anybody want to do it."

"Why should people care?"

"Inspiration is needed, and students need to understand the point."

"There is a lack of agency for people. AI is bigger than them, life is bigger than them. It won't change the needle, so why bother."

3.3.3. Teaching Challenges

A topic, which repeatedly came up in the discussion of challenges, was what should be taught and what needs to be taught on such an educational scheme.

"The second challenge is what to actually teach."

There was one general comment about how to teach. Projects should be included as students learning through discovery would help with their understanding.

"Project-based learning. Make them fight to figure it out."

One Thought-Leader mentioned including ethics in the course as AI is used for decisions.

"AI teaching needs to have ethics as computer science will be optimizing and decision making."

There were conflicting opinions as to whether coding needs to be included in this type of education. It is worth noting that one Thought-Leader who claimed that coding "always" had to be included when teaching AI, also does not think "everyone should learn to code." Another questioned whether coding needed to be included at all, or just understanding AI from a personal perspective was enough.

"Do people need to understand the technical side? Or is it just enough to understand how it touches their lives?"

"Being able to code"

One Thought-Leader thought that statistics needed to be included in AI education.

"From principles—understanding probabilities, Bayesian statistics as a way of looking at the world, distributions... Once you understand statistics, hook them in with what these can do—attractive applications."

Another issue pointed out was the lack of basic numeracy in the general public.

"Basic numeracy is a big issue, as a lot of people leave school without this."

They went on to further say this would be an issue for teaching the coding side of AI.

"If you were going to teach coding for data science and AI this [lack of basic numeracy] would be an issue, you should need to understand the gap."

3.3.4. Communities

A concept raised repeatedly in these interviews was around communities. It was pointed out by one Thought-Leader this could be approached "from a national, regional, and local level," and how such an educational scheme is approached "depends on how long you have and what resources."

The challenges faced by different demographics have already been mentioned, but here were specifically mentioned in relation

to AI training. No specific challenges or solutions were proposed, just that consideration must be given to the impact of AI and such courses on people's lives.

"Communication with different demographics is often very different and needs to be given consideration. Need to consider where will the courses be, and how will they be delivered."

"What are the challenges met by these people? Envision how AI would make their lives better."

"It raises the question are the tools we are designing even suitable or useful for these people?"

The potential impact of working with these communities and allowing their voices to be heard was pointed out by one Thought-Leader.

"One of the most powerful things you can do is to go and speak to communities, and give them a voice in parliament."

One solution to reaching the target demographic was putting a large effort and numerous resources across society behind such an idea to ensure success.

"A big national campaign. Every single fiber of academia, government, and industry working on this. Using popular culture and a big spend."

Charities: Another proposed way of connecting with relevant people was through charities, as they allow a link to those who may have been "forgotten" by other initiatives. This wealth of resources and expertise is often overlooked.

"The charity sector is often forgotten. How can we leverage charities, and how can we enable their people. For example, age concern, neurodiversity, and mental health. Considering the off-piste part of the population. Best way to connect to them is through charities. Those who are forgotten end up there."

A particular company, Simtton, in France was discussed by one Thought-Leader as they could be relevant to such an educational scheme. They offer training in data science and programming, targeted at disadvantaged communities where they will have the largest impact.

"Simtton—French large... training company. In programming and data science... What I like is that they target disadvantaged community. Who don't pay much to attend? They go to places with maximum impact social project. Training a 20-year-old student is easy. Takes more time to train people who have other things going on. Most social impact is where the money is rarest. It's a paradox."

Women: A Thought-Leader brought up focusing on women as this could be a forgotten angle, but one which could have the greatest impact.

"Returning-to-work workforce. Half the world's population—typically women who care for babies and parents. They come back to work, and tech has moved on."

3.3.5. Working with AI

The notion of different levels of "AI literacy" was a topic of interest in several of the interviews. One Thought-Leader described these as "three types of skills."

"One—fundamental skills—numeracy, literacy, digital skills, and ethics. These are the skills needed to function in everyday life"

"Two—people who have jobs where they will work alongside AI in work—lawyers, doctors, and accountants. Need to understand how it works, but not how to design it"

"Three—tech people—academics, developers—who will be building and designing the AI"

Another Thought-Leader gave farmers as an example of the second group. They will need to work with AI, but will not need to code or build it.

"It's actually past tech, for example farmers of seeds don't need to know the AI, but they will work with AI. Don't need to code, but need the ethics as they are a human supervisor."

The example of mechanics was given with reference to how humans interact with computers. Mechanics need to know the inner working of a car and how to fix it. Everyone needs to understand the basics if they use a car.

"I'm more interested in Human Computer Interaction, which everyone should have a basic understanding. An example I like to think of is the mechanic—who needs to understand exactly how a car works and how to fix. But everyone who has a car needs to understand the basics. It is a more holistic understanding, and it must include ethics and the social impacts of their work."

The word "coworking" was used to describe how machines and humans should be working together. It is noted that companies do not use this properly.

"There should be coworking with machines and humans. But, companies do not know how to utilize this."

This is further emphasized by discussions around tasks changing rather than jobs, and the need for empathy is as follows.

"Job losses. It is not jobs being automated, and it is little tasks. McKinsey studied the change in hours worked. They think it will be 52% more on technical stuff. You need social empathy—understanding how the tasks change."

3.3.6. A Final Thought

One Thought-Leader emphasized the importance of work done on this topic not being accessible only by those in academia.

“Make a version of your Ph.D. that is not academic. For normal people.”

3.4. Adult Educators

Interviews were conducted with companies who provide education for adults (generally 18 or 19+). These ranged from council run adult learning services based in a local library, an 8-week software engineering boot camp, and a provider of Data Science Apprenticeships. The last two can be grouped together as “for-profit” education providers.

The Adult Educators interviewed had a variety of roles—including director, tutor, head of subject, product manager, and learning designer. Prior to their current roles, their experiences ranged across industry, academia, and teaching bringing a wealth of unique experiences and viewpoints to the discussions.

3.4.1. What is AI?

All Adult Educators said they knew what AI was and were able to give a definition. These definitions were varied as some only claimed to know about AI in general, some taught or studied it, and one was a self-professed “hobbyist.”

3.4.2. Understanding and Interest

All interviewees thought their learners would understand and be interested in learning about AI. All council-run tutors thought their learners would understand unreservedly. Some of those interviewed raised caveats to their learners understanding.

The director of the council-run service pointed out that understanding and interest would be dependent on how such a course was delivered.

“It would entirely depend on how it was pitched”

This was expanded as the course not having a “lengthy, academic feel” or including watching “hour long videos.”

Those who claimed to know about AI (either through studying at university or by being a “hobbyist”) were more skeptical of what level their learners would understand.

“Understand is a big thing... Like I don’t understand AI like someone with a Ph.D. would... Given enough time. They would require a few more problems to understand abstract. Also, they would need help with analytics skills.”

“Basic concepts, yes. It is possible, depends on the depth... Basic classification, yes. More advanced maths, they might struggle with—like matrix multiplication.”

3.4.3. Challenges

Maths: Adult educator with a mentioned interest in AI (either through their studies or hobbies), all further specifically mentioned maths skills as being pivotal to an AI education. This may explain their reservations about everyone understanding an AI course.

“We need to explain the underlying mathematical ideas”

“More advanced maths”

“For example, for the maths, doing the exercises over and over does not work”

This transcends the interview categories and came across in other categories (particularly Thought-Leaders)—if the interviewee had studied anything related to AI, they mentioned the importance of mathematics. In all instances, this was brought up as a concern or challenge in teaching learners about AI. Maths was also mentioned by interviewees from council-run services, but more from the perspective of other courses they offer.

“In any subjects, maths is embedded throughout all courses. We like to ensure all our learners understand basic calculus.”

“Our Maths tutors are amazing—they more than teach, change people’s minds.”

Analytics: Those already teaching courses related to AI (all happen to be “for-profit” courses) all mentioned “analytics” in terms of skills or curriculum. Conversely, those teaching different courses did not mention this concept at all.

“they would need help with analytics skills.”

Career-Focus: “For-profit” companies are very career focused, particularly in terms of technology or data-science careers.

One interviewee actually mentioned the company was not considering the education from the learners’ point of view.

“They are not thinking about this from the learner’s point of view—they have not been in education for years, so do not understand the rigor. They also have a full-time job, a life, and a family. It is not an easy thing”

3.4.4. Design Considerations

Relevant and Embedded: The importance of making the education relevant to the learners was discussed by all Adult Educators.

“People incorporate education that they need and which affects their lives.”

“Adaptability... Flexibility of both platforms and formats... Bite-sized approach.”

“touches on their lives”

One suggestion to make it relevant was to find what motivates the learners (money, family, career, and community), and make the education about these.

“Money, immediate family, and career are the main things that motivate our people. They also have a strong duty and agreement with their local community. They care more about this than any national scheme.”

One way to make AI more relevant to their learners was to embed the subject into other topics. This was discussed by those

in a more strategic role, such as director, product, or learning designer.

“It is also woven throughout.”

“How can we in-corporate learning into work?”

“I would embed it as a topic in other courses.”

“embedded into other activities...”

Co-Designing: One interviewee suggested an educational scheme should be “co-designed with learners—actually adult learners, those with negative experience of education, diversity, and unemployed.”

They continued by discussing what would work for such a course would be “bitesize,” “could be done in chunks,” “embedded into other activities,” “this is AI, you should know what it is” “co-designed” “include things like what are you doing about your family or talking to your kids, their careers, the market.”

3.4.5. Charities and Women

A suggestion, which was also made by a Thought-Leader, was reiterated by an Adult Educator. They mentioned a possible way of reaching people is through charities and highlight one particular charity, Smartworks, which target out of work women who would potentially be available to attend training.

“Maybe look at the dress for success charity—Smartworks. They help find outfits for women and do interview prep skills. They are usually out of work, so could be a potential for classes.”

3.4.6. Final Thought

A piece of advice, which was given by one Adult Educator, which is useful to keep in mind, is as follows.

“It is important that people have the headache before you give them any aspirin.”

This quote was to illustrate that offering education on a topic irrelevant or unsuited to members of the public may not be deemed useful. Ensuring such an educational scheme was needed and wanted, and conversations with industry and members of the public were considered to be needed.

4. Discussion

The data presented in the findings provide insight into the AI education landscape. In considering these data through the lens of leaving no one behind as technologies such as RAI advance, three main themes have emerged, which could have significant impact on any future educational initiative aiming to ensure we leave no one behind: 1) Education for those working *with* RAI. 2) Overcoming preconceptions (of learners, industry, and experts). 3) Co-designing in communities.

It is also important to highlight some limitations with these findings and the resulting discussion. As described in the method, due to the nature of this research, the results are not

meant to be taken outside of the particular settings, places, and spaces of the interviews. They are not generalizable and are not intended to be taken as such. The interviews were focused on the UK, as the initial aim is to design education for a UK audience. The UK has a strong focus on AI, and it seemed logical to start with one country and expand from there in future research as AI education is a global discussion. Education is also not something which can be easily replicated country to country (take, for example, the Danish school system) as many political, social, and economic factors impact education, making the decision to focus on one country necessary. There are a wide range of socio-cultural issues, which would influence the attitudes and adoption of AI education that have not been covered by these interviews. This research does not touch on the many important technological, psychological, social, and environmental reasons, which impact attitudes toward technology and automation. These were not brought up in any of the interviews, so have not been included in the discussion.

4.1. Education for Those Working *With* RAI

There is a focus on education and retraining for those who will be developing, designing, or researching RAI. These are the group referred to by one of the Thought-Leaders as “tech people.” Typically, people in this group are already highly skilled and have a high level of education. It is predicted that these type of roles will increase in the short term; however, whether this will continue or be at risk of automation in the future is debated. However, this is not a group at risk of being left behind.

The original focus of this research was into education for the general public, in particular those at greatest risk of being left behind. However, a third piece seems to be missing—education for those working *with* RAI. This type of education was brought up in one of the Industry interviews and by several Thought-Leaders and would include those working in warehouses alongside robots and those working in call centers who may be working with algorithms and digital assistants. Roles such as these would not require employees to create or change the RAI systems. Employees would not need to understand in detail how these systems work, or how to code them. They would need a basic understanding of the workings, how to troubleshoot the systems and some knowledge around limitations and suitable uses. Creating working environments where humans and technology work alongside each other could be an important step as the Fourth Industrial Revolution advances. Education for these workers could prevent jobs losses and allay fears of RAI.

4.2. Overcoming Preconceptions

Previous work has highlighted the need to overcome preconceptions (both in education and in RAI systems themselves). The interviews highlighted three areas of preconceptions, which would need to be overcome for the planned education to be successful. First is the preconceptions, which every individual member of public will bring to such an education. Second, there are presumptions regarding the ability of members of public to learn about RAI from experts, which create potential barriers for

learners. Finally, the attitudes found in industry toward training will also need to be confronted and addressed.

4.2.1. Individual Preconceptions

All MoPs came across as comfortable discussing AI. They had opinions on AI, which were influenced by their individual lives, including their jobs and the news they consume. Such influences toward RAI need to be considered in the design of education.

The interviews in this research focused solely on AI, but due to the lack of distinction between AI and Robotics for MoPs, any future education scheme should be Robotics *and* AI. Their lack of distinction is shown by the examples of AI given being equally software and hardware examples (as shown in Figure 2). Very generally, AI is seen as software, and robotics is seen more as physical devices by experts (although this is not a hard rule, and potentially becomes confusing as AI and Robotics can exist in the same device). KPMG^[2] had a similar finding—those with less knowledge of AI did not distinguish between AI and Robotics. The examples given by MoPs were very broad—ranging from everyday hardware to use-specific software. The software examples included a lot of products from “Tech Giants.” The examples given were not ones, which would necessarily be expected, and overlooked a lot of more common examples of AI, such as self-checkouts. The examples from the news were mostly negative, which suggests how AI is sometimes portrayed by the media.

It is interesting to note that the inability to define AI is not limited to MoPs—no one from any of the other groups had a clear definition of AI. Within academia, industry, and policy, this is a constant discussion. This could be due to the word “intelligence” causing confusion, and further research into whether omitting this term in research for “data” or “coding” education could provide more clarity. The Elements of AI^[33] course goes as far to begin by saying a definition is not important. Perhaps, a similar attitude should be taken, and the focus shifted from definition to action.

Throughout the interviews, MoPs expressed more concerns than optimism (comparing Figure 3 and 4 confirms this). Several negative stories come from the news. The concerns also tended to be more specific and personal, whereas the optimisms were very general (e.g., it being useful). All of these perceptions of AI suggest there is a lot to be addressed in any AI education before anything substantial can be taught. This includes what RAI is, where it is used now, limitations, and how concerns can be addressed. Perhaps, this itself is more important than the general public actually understanding or building AI.

The MoPs shared concerns surrounding their data being used and shared. People in the UK are most comfortable sharing their data with the NHS,^[2] and this could be a useful way to help people understand AI.

When asked explicitly about AI training, most MoPs said they would not be interested. However, with discussion or further questioning, they all expressed an interest in training. Some rethought how training would be relevant to their lives, and others were interested in specific aspects; for example, understanding how AI works or the impact of AI on the public. This highlights the importance of language when discussing

AI education, and how reframing can attract more positive attitudes and different insights. The responses from MoPs regarding AI training showed this type of training is viewed as not widely available and only for experts or those in academia. This could reflect a wider view of education, as not being seen as for everyone. This barrier also needs to be overcome in the design of the education—ensuring the education does not feel academic or elitist and is relevant to those who need it most.

4.2.2. Expert Gatekeeping

An unexpected theme, which arose across groups, particularly the Thought-Leaders and Adult Educators, was the attitude of those who had studied AI from a technical perspective, or were self-confessed “hobbyists.” These technologists expressed their concern or disbelief that the general public could learn about AI. The issues they saw were with the mathematical ability, and coding skills of the general public. Such an attitude from those already exposed to AI could potentially be a form of gatekeeping, which will only enforce or increase inequality and digital exclusion. The responses on this theme seem to suggest some assumptions—first, an AI education requires understanding of underlying mathematical educations, and any AI education must include a coding component. Second, the general public would not be able to grasp these elements. These assumptions could stem from RAI education being focused on the technology side (for “tech people”). A further factor could be the lack of compulsory post-16 maths education in the UK, and the so-called “maths anxiety” experienced by many. It would be important to understand if these assumptions are held throughout the RAI community, particularly with technologists. If they do exist, understanding why they exist and how to overcome them would be necessary for an educational scheme to have the necessary support of the community.

Others questioned whether the general public would want to learn about AI. This ties in with the responses from the Members of Public into whether or not they would be interested in training in AI. It is worth noting, these views from those experts could feed back into the perception from the public that training on AI is not for them.

4.2.3. Industry Attitudes to Training

For any education or training in RAI specifically aimed at workers (including for those working *with* RAI) to be relevant and useful, industry needs to be involved in its design and delivery. Understanding the attitudes and approaches to retraining and education from companies likely to be impacted by RAI is imperative as they will be major players in avoiding workers being left behind.

The interviews with industry revealed two varying stances to retraining on AI—proactive and reactive. The proactive company was consciously thinking about the retraining needs of their warehouse employees. They ensured employees were trained on a number of roles and tasks to minimize disruption as tasks are automated. They also felt this gave employees a more satisfying experience in work. The reactive company waited until change happened to provide retraining only once there was a

business need for such training. While it is still positive that training is offered to some employees, this approach could cause potential job loss and does not focus on the employees and their needs.

Both companies involved in the research were founded in the past 20 years (in the same year), and both are publicly traded companies. They are both e-Commerce companies, with warehouses who deliver to consumers' homes, but operate in different goods. Based on their publicly available 2018 company reports, the proactive company has double the revenue and profit of the reactive one. The reactive company had three times as many employees as the proactive one. Both of these factors could go toward explaining the difference in attitudes toward automation and retraining. Having more money and less employees, and thus more money available for training per employee, could allow a proactive attitude to training more easily.

While these interviews show two varying attitudes in industry, other attitudes may exist and also need to be addressed. Working with companies to get a deeper understanding of these attitudes and how they would impact potential educational schemes for their employees, and if retraining could be leveraged to prevent job losses, could greatly increase the impact of such schemes. For education for those working *with* RAI to be impactful, the different attitudes will need to be understood and, perhaps, different ways for these companies to incorporate such education needs to be developed. Both PwC^[17] and WEF^[19] discuss the need for corporate training and education, particularly to negate the impacts of automation on those in roles, which do not require high levels of education or specifically sought after skills. WEF further discusses the need for collaboration among employers, government, and local education institutions. A potential way forward is co-designing education, which works for employers and employees.

4.3. Co-Designing with Communities

One concern raised by Thought-Leaders was how to reach the people this type of education would benefit most. One pointed out the areas where the most social impact can be made, often attract the least funding. A solution was also put forward in several interviews, which would be working with charities. Charities work with those often left behind and excluded. Several charities were suggested, and many more found, which could be partners for an educational scheme.

Educating women was also mentioned in the interviews. RAI, technology, and engineering are still male-dominated fields, and educating women could work toward a more equal workforce. Working with local communities, such as libraries, adult learning schemes, and other community points of interest, was discussed by the Adult Educators. A focus on making the education relevant and useful, with regards to families and local communities, would help its success. "Co-designing" the education with the people it would benefit was also seen as extremely important. Embracing co-design and working with local communities, through charities, would likely go a long way toward creating a relevant, useful educational initiative for those at risk of being left behind. Similarly, working with industry and unions, were appropriate, could create a more appropriate education for those working *with* RAI.

The final point in the MoP findings eludes to a viewpoint, which could be detrimental to the success of any RAI education of the public. Reasons for mistrust of education, academia, and technology are complex, work to understand and address these issues^[8,46] should be built upon and incorporated into education design and delivery.

It is worth noting here that co-design is a potential tool for rethinking a more equitable future. Ensuring the outcome of the fourth industrial revolution works for everyone needs more than just education, and co-design can be used to deliver this. Co-designing technology, laws, systems, and cities are becoming more common and have had success delivering solutions, which work for all parties involved.^[47–49] Co-designing RAI is another aspect, which could greatly improve attitudes and outcomes, and having RAI education either separate or part of this process could be an important way to drive success.

A framework for co-design as collaborative research is laid out in the work of Zamenopoulos and Alexious.^[50] Using such a framework to guide any further research could lead to greater inclusion, as the co-design could help understand why the initial response to AI training was negative. The aim of using co-design is to involve the learners from the beginning of the design process and to allow them to guide what they need and want. This type of flexibility in education design is often missing from formal education. Therefore, co-design may be a useful method for reaching those potentially left behind.

5. Conclusion

As technologies such as Robotics and AI advance, there is a risk of people being left behind if they are not given opportunities to learn about and use these technologies in both everyday life and work. Education for those most likely to be left behind needs to be designed specifically with these people in mind, as often other educational initiatives (such as returning to University) would not work for this group. To better understand the needs and attitudes toward RAI, particularly RAI training, semi-structured interviews with four groups of stakeholders were carried out; 21 individuals were interviewed from Thought-Leaders, Industry, Adult Educators, and Members of Public, as buy in from these four groups would be needed for any educational initiative to be successful. The data were analyzed using Thematic Analysis, and the findings viewed through a lens of no one being left behind.

The interviews with various groups were received positively, which suggests the needed support for such educational initiatives would be found. The interviews also highlight the amount of work, which still needs to be done. One important next step is to create separate educational initiatives for the community (to learn about RAI and the impact on their lives) and for those working *with* RAI (to learn about RAI and how to use it for their jobs). Both these educational initiatives need to be **co-designed** with the relevant communities (socially or industry). There are many preconceptions, which need to be overcome for education to be successful. The opinions of the learners based on their individual lives need to be addressed in any education. Potential gatekeeping from experts toward barriers may be preventing the public

from learning about RAI and need to be understood and overcome. As do the varying attitudes to training within industry.

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Conflict of Interest

The authors declare no conflict of interest.

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