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Science Education Tracker: Young people's awareness and attitudes towards machine learning

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Science Education Tracker:

Young people's awareness and attitudes towards machine learning

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Executive summary

Introduction

- This report presents findings from the machine learning module which was conducted as part of the 2016 Science Education Tracker (SET) survey. The SET survey is a survey of young people conducted by Kantar Public on behalf of Wellcome and supported by the Royal Society, the Department for Business, Energy and Industrial Strategy (BEIS) and the Department for Education (DfE).
- The core content of the SET survey is designed to provide evidence on a range of key indicators for science engagement, education and career aspirations among young people in England. The machine learning module, funded by the Royal Society, specifically focuses on young people's awareness of, and attitudes towards, machine learning applications.
- The SET survey is based on a nationally representative sample of 4,081 young people in school years 10 to 13 (aged 14-18) attending state-funded education in England. The machine learning module was addressed to a random half sub-sample of this population, a total of 2,044 young people. Within this subsample, the sample was further split and some questions were asked of a random quarter sub-sample (around 1,100 young people per question).
- Fieldwork was conducted online between June 29th and August 31st 2016.
- The results of this work complement a broader suite of public dialogue activity on machine learning, which has been carried out by the Royal Society's machine learning project, and which will be published in early 2017.

Key findings

- Awareness of machine learning applications varied. At least 70% of young people had seen or heard something about programmes which tailor web content based on browsing behaviour; voice recognition computers; facial recognition computers used in policing; and driverless vehicles. Young people were least familiar with robots used in a home care environment (such as caring for the elderly); robots used in the armed forces; and robots used in the finance industry.
- Male young people were more likely than female young people to be aware of each of the different machine learning applications asked about in the survey. Students with a high science quiz score, which is used as a measure of scientific knowledge, were more likely than students with a lower science quiz score to be aware of almost all of these applications.

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- While most young people (82%) were comfortable with the idea of computers recommending a movie for them to watch, there was a high level of mistrust in the use of machines to provide care for the elderly, and to control a car in which they are travelling; only around one in four trusted a machine for the latter two applications.
- In general, males were more trusting than females in the use of machines in an elderly care and transport setting, as were students with a high quiz score compared with students with a lower quiz score. In addition, level of trust in these applications was higher among students who were actively considering a career in science, technology, engineering or maths.

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Introduction

Background and context

Machine learning is a technology that enables computer systems to learn from data, so that they are able to carry out specific tasks by learning from examples. As the Royal Society notes:

> *"It is a form of artificial intelligence that we use every day: in internet search engines, email filters to sort out spam, websites to make personalised recommendations, banking software to detect unusual transactions, and lots of apps on our phones such as voice recognition."*[1]

The Royal Society is currently embarking on a project to explore the potential of machine learning over the next 5-10 years, and the opportunities and challenges associated with this technology[2].

Although there have been some recent studies covering the views of the adult public on machine learning (2014 Public Attitudes to Science survey; Eurobarometer 2012 & 2014) there has been limited quantitative evidence concerning the views of young people.

To help address this deficit, the Royal Society funded a short module as part of the 2016 Science Education Tracker survey which focussed on awareness of, and attitudes towards, machine learning and its applications among young people aged 14-19.

This module complements a broader set of public engagement activities on the subject of machine learning, which the Royal Society has carried out as part of its machine learning project. Through a quantitative survey and a series of public dialogue sessions across the UK, the Royal Society has been exploring public attitudes to machine learning and its applications. Engaging with the public in this way has been key in informing the findings of the machine learning project. The results of this work will be published as a separate document in early 2017, alongside the broader findings of the project.

The Science Education Tracker

The Science Education Tracker (SET) is a new survey of young people in Years 10 to 13 attending state-funded education in England. The survey was conducted by Kantar Public on behalf of the Wellcome with support from the Royal Society, the Department for Business, Energy and Industrial Strategy (BEIS) and the Department for Education (DfE). The survey provides evidence on key indicators for science engagement, education and career aspirations among young people in England.

The SET survey has built on two previous studies conducted on behalf of Wellcome, the Wellcome Monitor Waves 1 and 2 conducted in 2009 and 2012[3]. The first two waves of the Wellcome Monitor were large-scale face-to-face surveys of adults and young people aged 14+. Each of these studies

[1] https://royalsociety.org/topics-policy/projects/machine-learning/about-machine-learning-project/

[2] See footnote 1

[3] https://wellcome.ac.uk/what-we-do/our-work/public-views-medical-research

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included a sample of around 400 young people aged 14-18. From 2015 (Wave 3), the Monitor survey focused on adults aged 18+ only and a bespoke Science Education Tracker survey was established to focus on understanding young people's experience of science inside and outside of school and how this influences decision-making around science-based subject and career choices. The survey represented a departure from the Monitor survey series in several respects: the survey moved from face-to-face interviewing to online self-completion; the sampling frame changed; and the sample size was substantially increased to allow more detailed analysis by school year cohorts and population subgroups.

The machine learning module

As an addition to the core content of the SET survey, two supplementary modules were included: a short module on awareness and attitudes towards machine learning funded by the Royal Society (reported here) and a short module on attitudes towards biomedical science funded by Wellcome.[4] Each of these modules was asked of a randomly selected half of the main sample. The machine learning module is based on a sample of 2,044 out of the 4,081 respondents that completed the SET survey. Within this subsample, the sample was further split and some questions were asked of a random quarter sub-sample (around 1,100 young people per question).

The survey included questions on the following:

- The extent to which young people had seen or heard about machine learning applications in a variety of settings including transport, medicine, social care, finance, military and computing.
- The level of trust amongst young people in the use of machine learning for specific applications, including recommendation systems for online retail, care for the elderly and driverless car technology.

SET Survey Methodology

Further information about the survey background and methodology can be found in the Technical Report, available from the UK Data Archive while the reports are on the website. Key details are as follows:

- The sample is a random sample of young people in school years 10 to 13 (aged 14-18) attending state-funded education in England. It was drawn from a combination of the National Pupil Database (NPD) and the Individualised Learner Record (ILR).
- All sampled individuals were sent a letter inviting them to take part in a survey; for young people aged under 16 correspondence was directed via parents. Respondents then completed the survey online.
- Respondents were asked questions about a range of topics including their experience of science education, their plans for the future and their attitudes towards science-related careers. The questions drew on existing surveys such as the Wellcome Monitor, as well as newly developed questions for this survey. The questionnaire wording and content was also informed by focus groups with young people commissioned by Wellcome at the outset of the project. All new questions were cognitively tested with young people prior to administration.

[4] The findings for the biomedicine module can be found at: https://wellcome.ac.uk/what-we-do/our-work/young-peoples-views-science-education

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- A field pilot of c. 200 online completions was conducted before the main survey to test and pilot survey procedures.
- Respondents were able to complete the survey on any online device, including PCs, laptops, tablets, and mobile phones.
- 4,081 respondents completed the survey between June 29th and August 31st 2016, representing a response rate of 50%[5]. Questions related to the September 2015-July 2016 school year which respondents had recently completed.
- This response rate was achieved after sending an initial invitation and up to three reminders. Reminders were targeted at groups with the lowest response rates in order to maximise the representativeness of the sample. The achieved sample closely matched the population on a range of demographic variables; data were weighted to ensure that the sample profile fully matched the population profile.

Linking survey responses to administrative data

All respondents were asked their permission for administrative data from the NPD to be linked to their survey answers: 83% gave permission for their data to be linked. This administrative data included (amongst other data):

- eligibility status for free school meals
- whether English is the young person's first language
- academic results from Key Stage 2 and Key Stage 4[6].

The 17% of respondents who did not consent to data linkage were asked some additional questions about qualifications achieved to cover some of the items that would have been drawn from the NPD.

Science quiz

In the Wellcome Monitor, respondents were asked a series of true / false questions relating to knowledge of different areas of science such as genetic modification, DNA, electrons and mass. A very similar knowledge quiz was used in the Science Education Tracker.

Respondents were classified into one of three groups based on their score from the knowledge quiz:

- Low (23% of respondents) – 0-5 correct answers;
- Medium (57% of respondents) – 6-8 correct answers;
- High (20% of respondents) – 9-10 correct answers.

Throughout this report, the knowledge quiz scores are used as a measure of scientific knowledge and as a proxy for attainment in science. For respondents in Years 12 or 13 who had agreed to link NPD data to their survey answers, we were able to compare knowledge quiz scores with achieved Key Stage 4 science results. A moderate Pearson's correlation coefficient of 0.5 was observed between quiz score and Key Stage 4 results, indicating that there is some overlap with qualifications.

[5] Response rate is calculated as: number of completed interviews / number of cases issued. This corresponds to Response Rate 1, as calculated by the American Research Association for Public Opinion Research (AAPOR, 2016, Survey Outcome Rate Calculator 4.0).

[6] Key Stage 4 data was only available for young people who had already completed these exams. This was primarily young people in Years 12 and 13

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Structure of report

The report is structured as follows:

- Chapter 1 considers young people's familiarity with different machine learning applications and the variation in this across different demographic sectors
- Chapter 2 explores young people's attitudes towards three specific areas of machine learning: recommendation engines, driverless vehicles and care of elderly.

Reporting conventions

All differences commented on in this report are statistically significant at the 95 per-cent level of confidence. All percentages reported are weighted to account for differential nonresponse.

Where percentages do not sum to 100 percent or to net figures, this will be due to either (i) rounding or (ii) questions which allow multiple answers.

Respondents were able to refuse to answer any question by selecting 'prefer not to say'. Where a respondent refused an answer, they have not been included in the analysis for that question. 'Don't know' responses are included in all questions reported except where otherwise specified.

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1. Awareness of machine learning applications

This chapter considers young people's familiarity with different machine learning applications and the variation in this across different demographic sectors.

1.1 Overall level of awareness

Young people were asked about the extent to which they had seen or heard about a number of different examples of machine learning, where machine learning was defined in the questionnaire as "*… when machines or computers are able to adapt, learn and make recommendations or decisions on their own without a human giving them ongoing instructions".* Applications covered specific examples across the domains of home computing, policing, transport, medicine, military, finance and social care.

At least half of young people reported having heard something about each of these examples (see Figure 1.1). However, there was substantial variability in responses by different applications. The applications which attracted most recognition were those which concerned everyday digital interactions such as programmes that tailor web content based on browsing habits (85% had heard something about this) and computers that recognise and process speech (again 85% recognition level). Facial recognition computers used in policing were also heard of by a similar proportion (83%) while 79% had heard of driverless vehicles.

Applications which were not as well-known to respondents included machine learning applied in the areas of medicine; caring for the elderly; military applications; and finance. It is worth noting that the question regarding the use of robots in the military did not include any mention of the term "military drone" which has been the subject of extensive media coverage in recent years. It is possible that awareness may have increased if this potentially more familiar term had been used.

It is not possible to compare these findings with the 2014 Public Attitudes to Science (PAS) survey (Castell *et al*, 2014) which also captured awareness of different robotic applications, as the questions asked were very different in format. However, one area of alignment is that the use of robots in the care of older people was one of the least well-known areas in both surveys.

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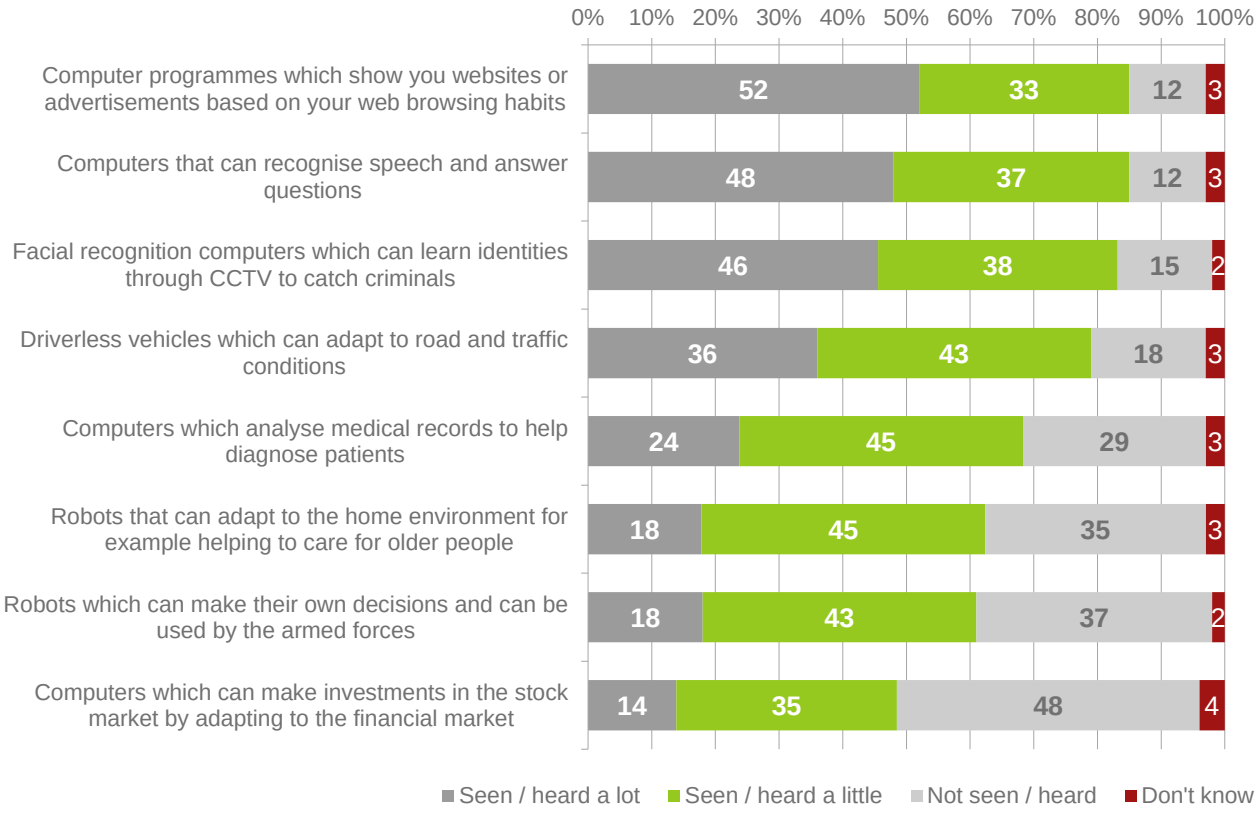
Figure 1.1: Awareness of different machine learning applications

Q. Machine Learning is when machines or computers are able to adapt, learn and make recommendations or decisions on their own without a human giving them ongoing instructions. Have you seen or heard anything about…?



Base (All respondents): Total (websites: 1,094; speech: 1,089; CCTV: 1,091; vehicles: 1,088; medical records: 1,090: elderly care: 1,092; armed forces: 1,093; investments: 1,093)

1.2 Awareness by demographic subgroups

There is a strong gender differential in terms of awareness of machine learning applications (Figure 1.2). Males were more likely than females to have seen or heard “a lot” about each type of application. The strongest gender divides were seen in relation to awareness of driverless vehicles where males were twice as likely as females to have seen or heard a lot about this (49% compared with 24%); also the use of robots in a military setting (25% compared with 10%).

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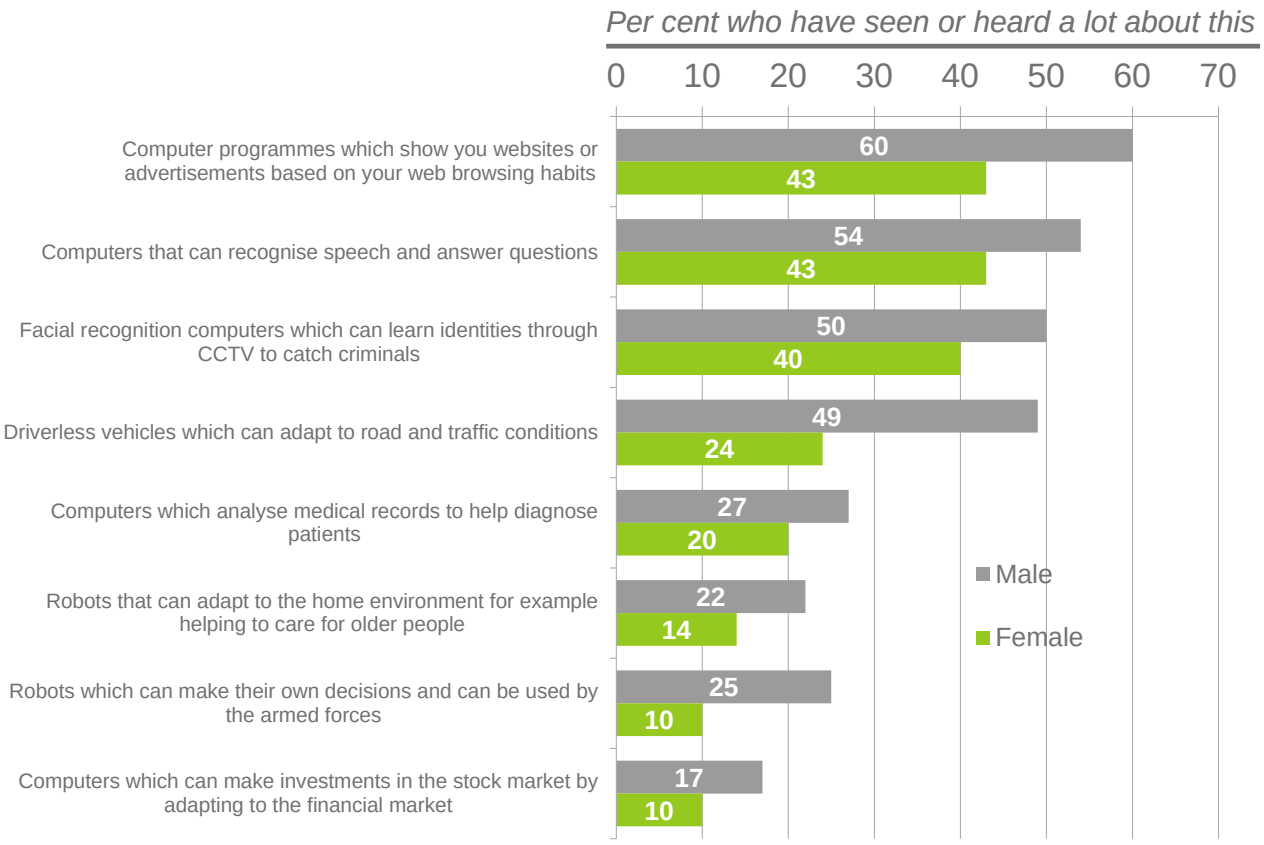
Figure 1.2: Awareness of different machine learning applications by gender

Q. Machine Learning is when machines or computers are able to adapt, learn and make recommendations or decisions on their own without a human giving them ongoing instructions. Have you seen or heard anything about…?



Base (Males): Total (websites: 515; speech: 495; CCTV: 524; vehicles: 522; medical records: 506: elderly care: 528; armed forces: 526; investments: 512)

Base (Females): Total (websites: 569; speech: 587; CCTV: 556; vehicles: 556; medical records: 576: elderly care: 555; armed forces: 557; investments: 570)

Awareness of machine learning applications was also related to the science knowledge quiz score which has been used in the SET survey as a proxy for science-related knowledge (see Figure 1.3). Students with a high quiz score were more likely than those with a low quiz score to have seen or heard “a lot” about each of the areas of application, with the sole exception of machine learning in the finance sector where there was a low level of familiarity across all knowledge groups.

It is also of little surprise that students who have studied computer science at GCSE were more likely than average to have heard of each of these applications. For example 63% of students studying computer science GCSE had heard a lot about computers that recognise and act on speech (compared with 45% of students who had not studied this) and 51% had heard a lot about driverless vehicles (compared with 34% of students who had not studied this).

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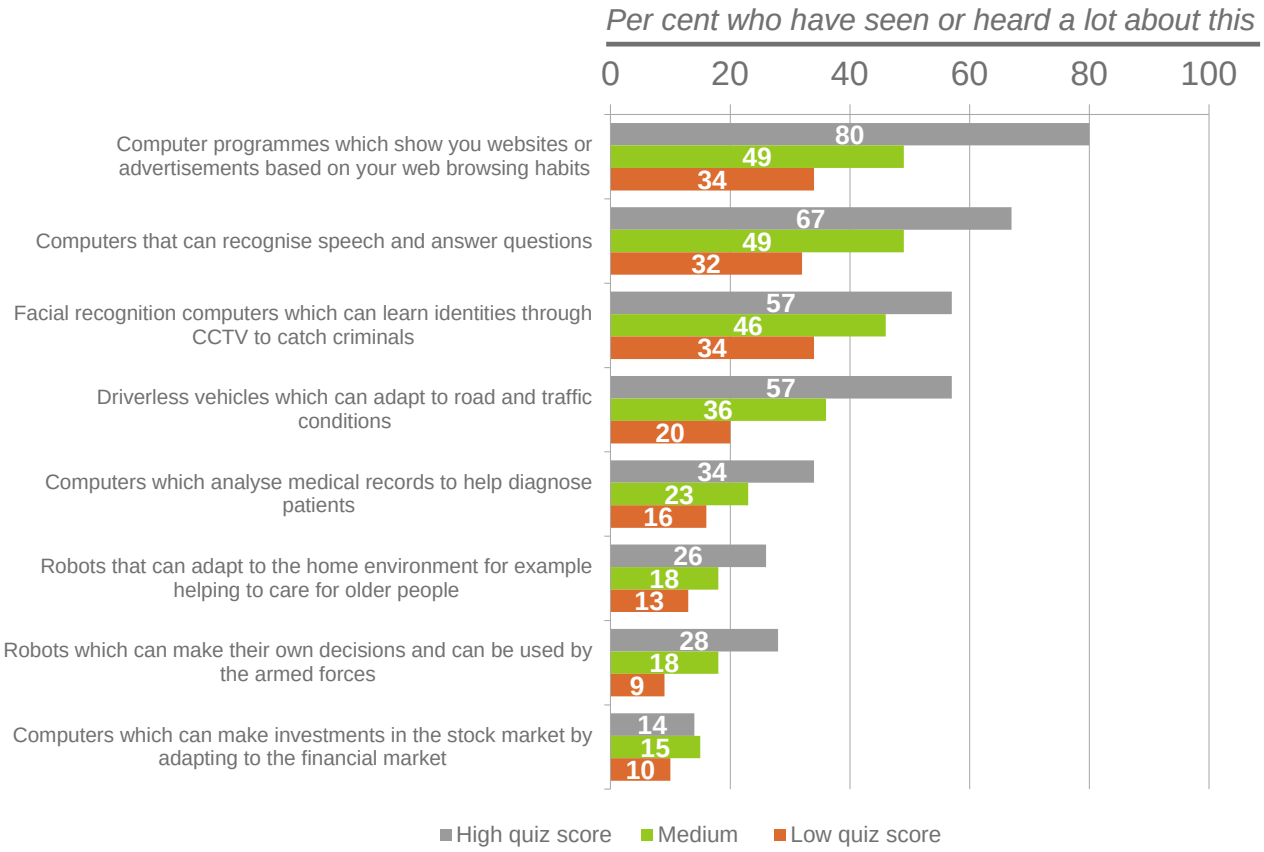
Figure 1.3: Awareness of different machine learning applications by science quiz score

Q. Machine Learning is when machines or computers are able to adapt, learn and make recommendations or decisions on their own without a human giving them ongoing instructions. Have you seen or heard anything about…?



Base (High quiz score): Total (websites: 224; speech: 218; CCTV: 232; vehicles: 232; medical records: 225: elderly care: 237; armed forces: 234; investments: 243)

Base (Medium quiz score): Total (websites:624; speech: 623; CCTV: 628; vehicles: 606; medical records: 612: elderly care: 625; armed forces: 611; investments: 602)

Base (Low quiz score): Total (websites: 246; speech: 248; CCTV: 231; vehicles: 250; medical records: 253: elderly care: 230; armed forces: 248; investments: 248)

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2. Trust in machine learning applications

This chapter explores young people's attitudes towards three specific areas of machine learning: recommendation systems used in online retail, driverless vehicles and care of older people.

2.1 Overall level of trust

There is an emerging body of literature on the level of support for different automated systems within the adult population. The 2014 Public Attitudes to Science survey (Castell *et al*, 2104) identified that adults were, on balance, supportive of the use of unmanned planes in military operations but less supportive of robots to act as companions for elderly people, to carry our medical operations and to control driverless public buses. A high level of distrust for robots to perform surgery and drive public buses was also found in a more recent survey on behalf of the British Science Association (BSA, 2016).

A Eurobarometer study (Eurobarometer 2015) mirrored these findings, identifying only around one in five UK adults feeling comfortable with the idea of having a medical operation performed on them by a robot; having a robot provide services and companionship to elderly or infirm people; and travelling in an autonomous vehicle. However, based on a EU wide average, the level of support for robots in a social care setting was higher among young people aged 15-24 (37% feeling comfortable) declining across the age groups (to 25% of those aged 55+) with a similar age related pattern for travelling in a driverless car (27% declining to 16% of those aged 55+). Across the EU in the Eurobarometer survey, support for the use of robots in medical applications was constant across all age groups (around 25%).

The cautious support by young people for the use of robots in an elderly care environment was also echoed in a 2010 study which found that young people in a public dialogue setting recognised the advantages of robots in helping to combat loneliness and promote independence among older people (Bultitude, 2010). However, there were concerns around trust and reliability, affordability and the extent to which robots can replace human involvement.

In the SET survey, the level of trust varied considerably by the nature of specific applications (see Figure 2.1). The large majority (82%) indicated that they would trust a machine or computer to recommend a movie that they would enjoy; many young people will have been exposed to and used such recommendation engines in their own life.

However, young people were more distrustful about other applications. On balance, more young people distrusted than trusted the use of autonomous systems based on machine learning to care for an elderly person in their own home (28% trusted and 64% distrusted this); and the use of machine learning to control a car in which they were travelling (24% trusted and 70% distrusted this).

These findings are broadly in line with adult views in the Eurobarometer 2014 study, where only 23% of UK adults felt comfortable with the idea of having a robot to provide services and

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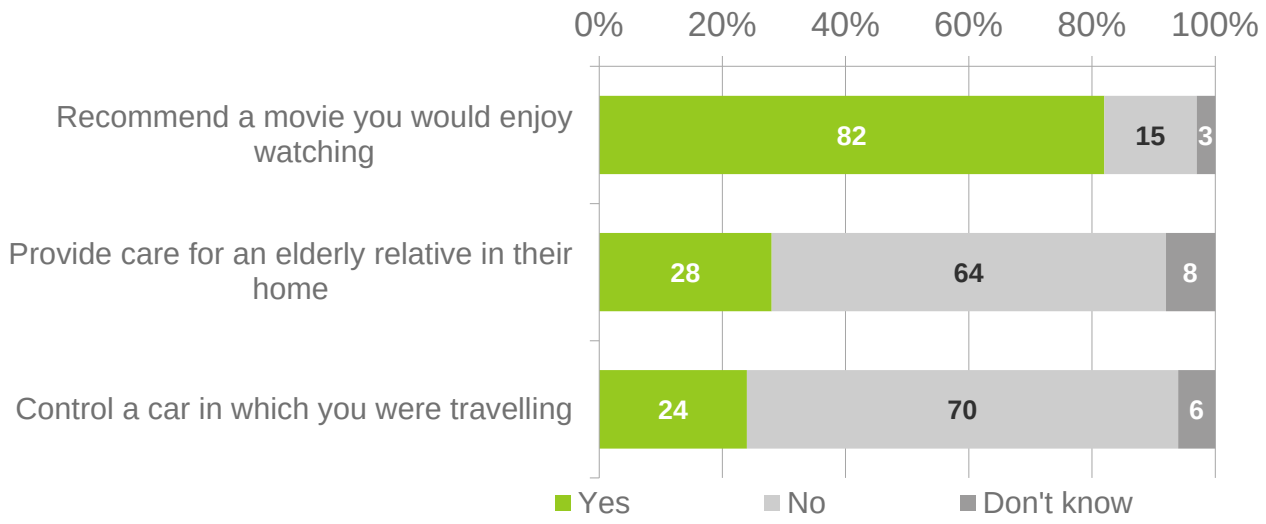
companionship to elderly or infirm people and only 21% felt comfortable with the idea of travelling in a driverless car.

Figure 2.1: Level of trust in three different applications

Q. Would you trust a machine or computer to…?



Base (All respondents):Total (Movie: 2,023; Elderly: 2,037; Car: 2,037)

Trust in computers to recommend a movie did not vary by gender, remaining uniformly high across both genders. Young people with a high quiz score were somewhat more likely than those with a low quiz score to trust this technology (88% compared with 74%).

However, there were some more noteworthy differences by subgroup in relation to trust in driverless technology and use of robots to provide elderly care. In both of these scenarios, males were more trusting than females, and students with a high quiz score were more trusting than those with a low quiz score. Students who were interested in a career involving STEM (science, technology, engineering or maths) also had more confidence in these applications of machine learning than students who held alternative career ambitions. See Figure 2.2.

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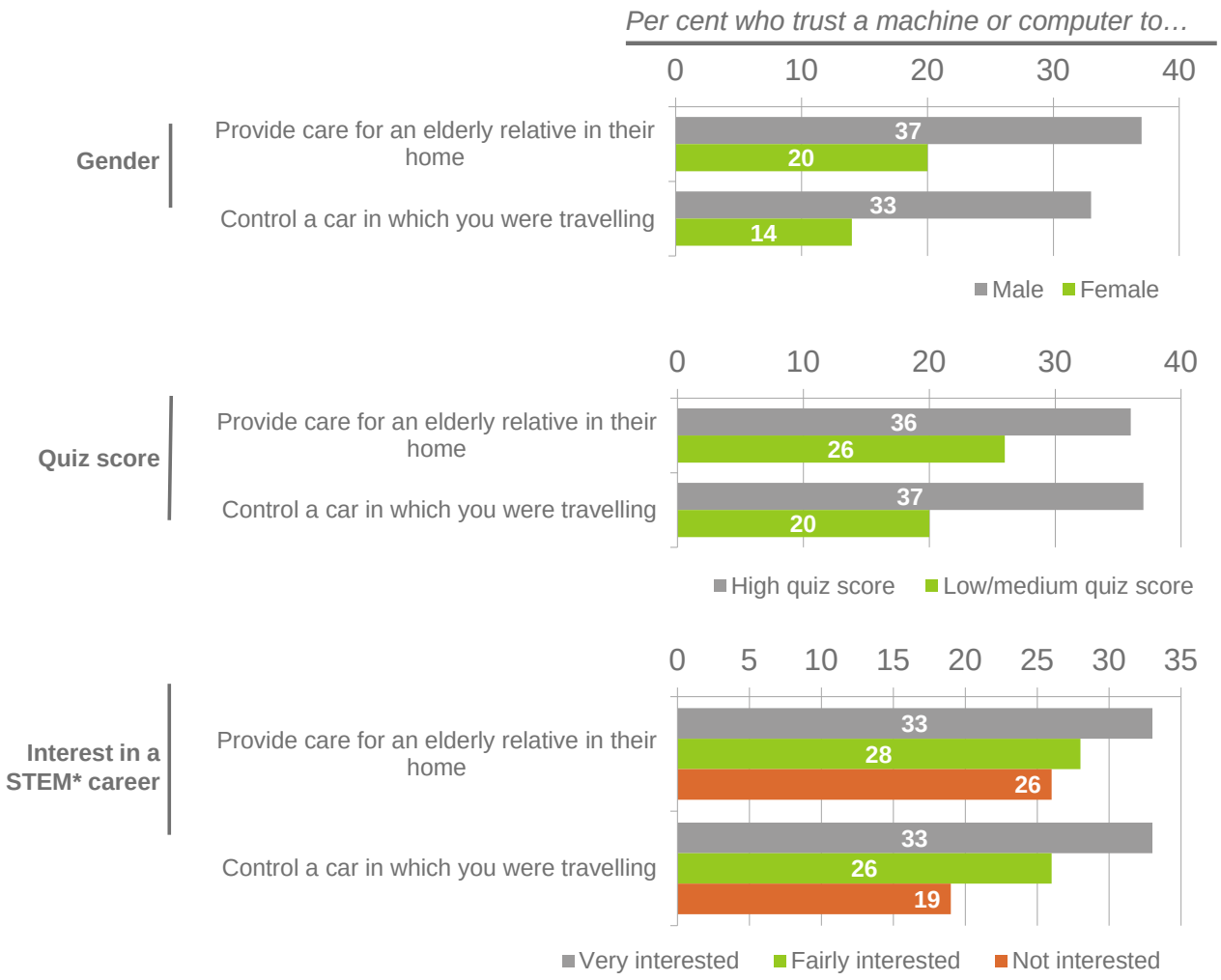
Figure 2.2: Level of trust in three different applications by gender, quiz score and interest in a STEM* based career

Q. Would you trust a machine or computer to…?



Base (All respondents):Males (Elderly: 948; Car: 950); Females (Elderly: 1,061; Car: 1,063); High quiz score (Elderly: 439; Car: 439);Low/medium quiz score (Elderly: 2,037; Car: 1,585);Very interested (Elderly: 405; Car: 405);Fairly interested (Elderly: 475; Car: 477);Not interested (Elderly: 1,012; Car: 1,012).

* STEM = science, technology, engineering and maths

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