

NEVER TOO LATE: PROFILING FEMALE ENGINEERING APPRENTICES.

Institution of
**MECHANICAL
ENGINEERS**



Improving the world through engineering





Although women are under-represented in many STEM areas, this is particularly stark in engineering apprenticeships. Not only does this lead to inequalities in pay, but this gender imbalance has significant implications for the supply of skills into the economy.

Jenni French

Gatsby Charitable Foundation



Female engineering apprentices are something of a rarity, but there is no evidence that they are 'a breed apart'. The UK school population may include many more young women who could be attracted to this career route, given the right opportunities.

Peter Finegold

Institution of Mechanical Engineers

The Institution of Mechanical Engineers is a not-for-profit membership organisation under Royal Charter, and a registered charity (No. 206882). The Institution, which has over 120,000 members in 140 countries, is an independent professional association that represents mechanical engineers and the engineering profession, and strives to improve the world through engineering. The Institution aims to be the recognised voice in mechanical engineering, supporting a global engineering community. The Institution of Mechanical Engineers' goals are to:

- Develop engineers
- Promote engineering
- Inform opinion
- Encourage innovation

Gatsby is a foundation set up by David Sainsbury to realise his charitable objectives. We focus our support on a limited number of areas:

- Plant science research
- Neuroscience research
- Science and engineering education
- Economic development in Africa
- Public policy research
- The arts

Our education programme focuses on strengthening science and engineering skills in the UK workforce through a range of innovative programmes and partnerships.

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FOREWORD



In recent years the engineering community has made a concerted effort to broaden its appeal beyond traditional archetypes. In promoting apprenticeship routes and by being open to all sections of society, employers now acknowledge how a successful engineering sector needs all kinds of talented people from different backgrounds, interests and learning styles.

This research study has brought together two leading organisations working in this area. The Gatsby Charitable Foundation's trusted research and policy activity has helped guide Government policy in areas such as apprenticeships, technical education and careers. While the Institution of Mechanical Engineers' own research focuses on a deeper understanding of young people's career decision-making.

A core challenge in ensuring that engineering is more representative of society, is in attracting more women to become engineers. Maybe we'll know we've been successful when female engineers are so commonplace that no-one even thinks about their gender, just the ability and talent of each individual.

My own career started in the shipbuilding industry as a mechanical engineering apprentice, where I learned my trade and had the most amazing preparation for being an engineer. This training set me up to study at university, and after graduation, I worked as a design engineer in defence, a systems engineer in the space industry, and became a lecturer in mechanical and manufacturing engineering in further and higher education.

I found it a real privilege to work under the guidance of technical experts, who generously shared with me their years of experience to enable me to become the best I could be. I learned to appreciate that everyone has a crucial role to play in manufacturing a submarine, an Earth remote sensing satellite or building an aircraft wing. I've managed to maintain this 'apprenticeship ethos' and I believe this was a factor that contributed to my being awarded Woman of Year for Science and Technology in Wales in 2005.

I don't feel that my career path should be seen as unusual or exotic. Too often we either disregard the potential of girls to become engineering apprentices, we immediately leap to the conclusion that a minority of young women exist who are intrinsically disposed towards engineering.

This insightful study shows how there isn't an obvious engineering apprentice type – male or female – and that when women choose engineering, they tend to do so later. Which is why getting careers guidance right in our schools and colleges is so important.

The Institution of Mechanical Engineers, together with the Gatsby Charitable Foundation, has produced another thought-provoking piece which I am delighted to endorse, since it offers a clear set of targeted recommendations on how engineering can reach out to all potential engineers through insightful understanding of their drivers and ambitions.

Professor Helen James
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EXECUTIVE SUMMARY

Some 494,900 apprenticeship started in England in 2016/17, 53% of them by women. Yet women accounted for just 8% of those starting apprenticeships in the engineering sector that year^[1]. Similarly, with numbers marginally below 6,000, in 2015–16, just 16% of students embarking on a first degree in engineering and technology were female^[2].

In a bid to understand more about female engineering apprentices and what motivated their career pathway, the Institution of Mechanical Engineers and Gatsby Charitable Foundation jointly devised and funded a research study carried out by ICMUnlimited, comprising a survey of female and male engineering apprentices and undergraduates, as well as non-engineering apprentices for comparison.

The results identified a range of features associated with female engineering apprentices:

- Their academic achievement is above average, and they have a broad range of academic interests including (but not limited to) STEM subjects.
- They are strongly work-oriented – they prefer hands-on to academic study, have typically had some paid employment before the age of 18, and are highly debt-averse; they do not see a degree as a prerequisite for a successful career.
- They are less likely than male engineering apprentices to be inspired by 'tinkering' and more likely to be inspired by creative crafts and arts-related activities.
- Family history can have a significant influence on their choice of career pathway; provision of careers information in schools was felt to be particularly poor in meeting their needs and most apprentices had based their decision on their own research.
- They are more likely to come to engineering late and less likely to have always wanted to be an engineer.

A segmentation analysis of survey responses identified four clearly demarcated segments among females and males choosing engineering, determined by their responses to a battery of questions:

- Ambitious Aspirers – studious yet practical
- Persistent Pragmatists – practical problem-solvers
- Intellectual Independents – free-thinking theorists
- Accidental All-rounders – creative and open

Female engineering apprentices were spread across all four segments, which suggests that they do not fall into a single, easily identifiable group. However, they were over-represented in the Persistent Pragmatists and Accidental All-rounders segments.

Individuals in the Persistent Pragmatists category typically had long-standing engineering-related interests. By contrast, Accidental All-rounders had a broad range of academic interests and a creative mindset. Accidental All-rounders were more likely to have arrived at engineering relatively late, possibly because they were (erroneously) not identified as individuals likely to be interested in engineering-related careers. This group, which make up nearly 30% of the research participants and 35% of female engineering apprentices, had very negative views about schools careers advice.

These findings suggest that a significant proportion of female engineering apprentices are intelligent (but not academically 'high-flying'), have wide-ranging interests, including in creative and craft subjects, and exhibit a down-to-earth attitude to life and career. These young women may not have been seen as likely to pursue engineering-related careers, and school careers advice did not serve them well, leaving them heavily influenced by family experience, reliant on their own research, or dependent on chance events or connections.

Given the characteristics of this group of young women are likely to be widely shared, the findings suggest there may be a missed opportunity to target significant numbers of girls who, with a higher level of awareness and nurturing, might be attracted to engineering apprenticeships.

The study also suggests that for young women, the window of opportunity remains open for longer than thought – up to and beyond the late stages of a school education. Promotion of engineering in schools has focused on primary and early secondary education. This research suggests that these efforts should be complemented by career-oriented information programmes targeting later stages of schooling, emphasising messages likely to resonate with the values, attitudes and broad interests of female students.



I just thought, I want to be working; I want to be earning money... I outgrew a lot of my friends who had gone to uni – you stay younger (if you go to university). I had a job and a car and my own money, while they were still like 'I can't afford to go out for tea tonight'... I grew up a lot faster.

Female apprentice engineer

RECOMMENDATIONS

1. Employers, FE colleges and other organisations wishing to attract women into engineering apprenticeships, should broaden their targeting to include those with interests in creative crafts and the arts.
2. Engineering careers initiatives should develop programmes that target young women aged 15–25, since female engineering undergraduates and apprentices appear to make their career decisions later than their male counterparts.
3. The Government's Careers Strategy includes a legal duty for education and training providers to have access to all maintained schools and academies in England. The engineering community should ensure that it offers practical support and advice to organisations who wish to promote the value of engineering apprenticeships in schools.
4. EngineeringUK, along with its partners in the engineering community, should draw on the report's findings, as they work together to reposition the Tomorrow's Engineers programme; specifically to act on the knowledge that women choosing routes into engineering careers tend to make this decision later, and that their hobbies and interests are less likely to be 'tinkering' and more likely to be linked to creative crafts and arts.
5. STEM Learning Ltd should recruit a cadre of female engineering ambassadors who are trained to highlight specific messages about engineering apprenticeships, including:
 - The creative problem-solving aspects of engineering.
 - The suitability of engineering careers, even for those who have not harboured a longstanding interest in the subject.
 - How the changing nature of engineering and technology will require future engineers with a variety of skills and interests.

INTRODUCTION

Apprenticeships are seen as an important part of the answer to the UK's technical skills gap, and more generally as an undervalued alternative to university for developing work-related skills. Some 494,900 young people were enrolled on apprenticeships in England in 2016/17, and the total number of active apprenticeships reached 912,200; about 74,000 new starts (15%) were in engineering-related roles. However, while 53% of new apprentices are female, there is a striking gender imbalance in engineering – only 8% of engineering apprentices are women.

The past decade has seen a strong drive to increase the number and quality of apprenticeships. Since 2010/11, about 500,000 new apprenticeships were started each year, linked to strong support from Government. Yet the percentage of female engineers remains stubbornly low.

To provide more insight into the characteristics of women who do choose engineering apprenticeships, in 2017 the Institution of Mechanical Engineers and Gatsby Charitable Foundation commissioned the research agency ICMUnlimited to undertake a survey of current and newly qualified female and male engineering apprentices and undergraduates, as well as non-engineering apprentices. The goal of the research was to identify distinctive characteristics of the female apprentices, by comparing their shared personality characteristics, their educational experience and the rationale behind their choice of career pathway with those of the other groups.

The aim of this research was to derive insights into this small group, that would inform understanding of who should be targeted and how they could be targeted. This would provide valuable input into the design of policy and interventions to increase representation of women in engineering career pathways, particularly apprenticeships.

SUMMARY OF RESEARCH

During an exploratory qualitative phase, 18 in-depth interviews were carried out with female and male apprentice engineers, undergraduate engineers and non-engineering apprentices. Insights from these interviews were used to inform the development of a quantitative online survey. The survey contained a range of profiling, attitudinal and behavioural questions designed to capture key aspects of each audience.

The survey was circulated to (1) current and recent engineering undergraduates, (2) current and recent engineering apprentices and (3) current non-engineering apprentices. In total, the survey was completed by 646 people with an engineering background (including 89 female engineering apprentices) and 240 non-engineering apprentices (including 117 women). The sample was obtained through a variety of routes, including requests sent out by third-party organisations such as Senta, Transport for London's women's network and through the Institution of Mechanical Engineers' member communications and networks.

During data analysis, ICM carried out a segmentation of all engineering participants (undergraduate and apprentices), to provide insights into the characteristics of people currently studying or training to become engineers. The segmentation was based on shared patterns of survey responses, which demarcated clusters of individuals sharing similar attitudes and characteristics. This analysis was used to determine whether female engineering apprentices were over- or under-represented in any of the segments identified. Segmentation was carried out to see if female engineering apprentices formed a unique group.

A detailed set of survey data and the segmentation analysis can be found in the full project information pack available at www.imeche.org/policy-and-press/reports/detail/never-too-late-profiling-female-apprentices

Profile Key

 <p>Female Engineering Apprentice</p>	 <p>Female Engineering Undergraduate</p>	 <p>Female Non-engineering Apprentice</p>
 <p>Male Engineering Apprentice</p>	 <p>Male Engineering Undergraduate</p>	 <p>Male Non-engineering Apprentice</p>

MAIN FINDINGS: PROFILING



I would say that, in the apprenticeship, there are a lot of people that either have relatives that work here or are engineering-based. I guess the reason that encourages people to come in is, they're able to see more clearly what is involved and... understand it a bit more, whereas people coming at it completely fresh might be quite... scared by it. They don't know enough about it, there aren't the resources available to find out easily about engineering.

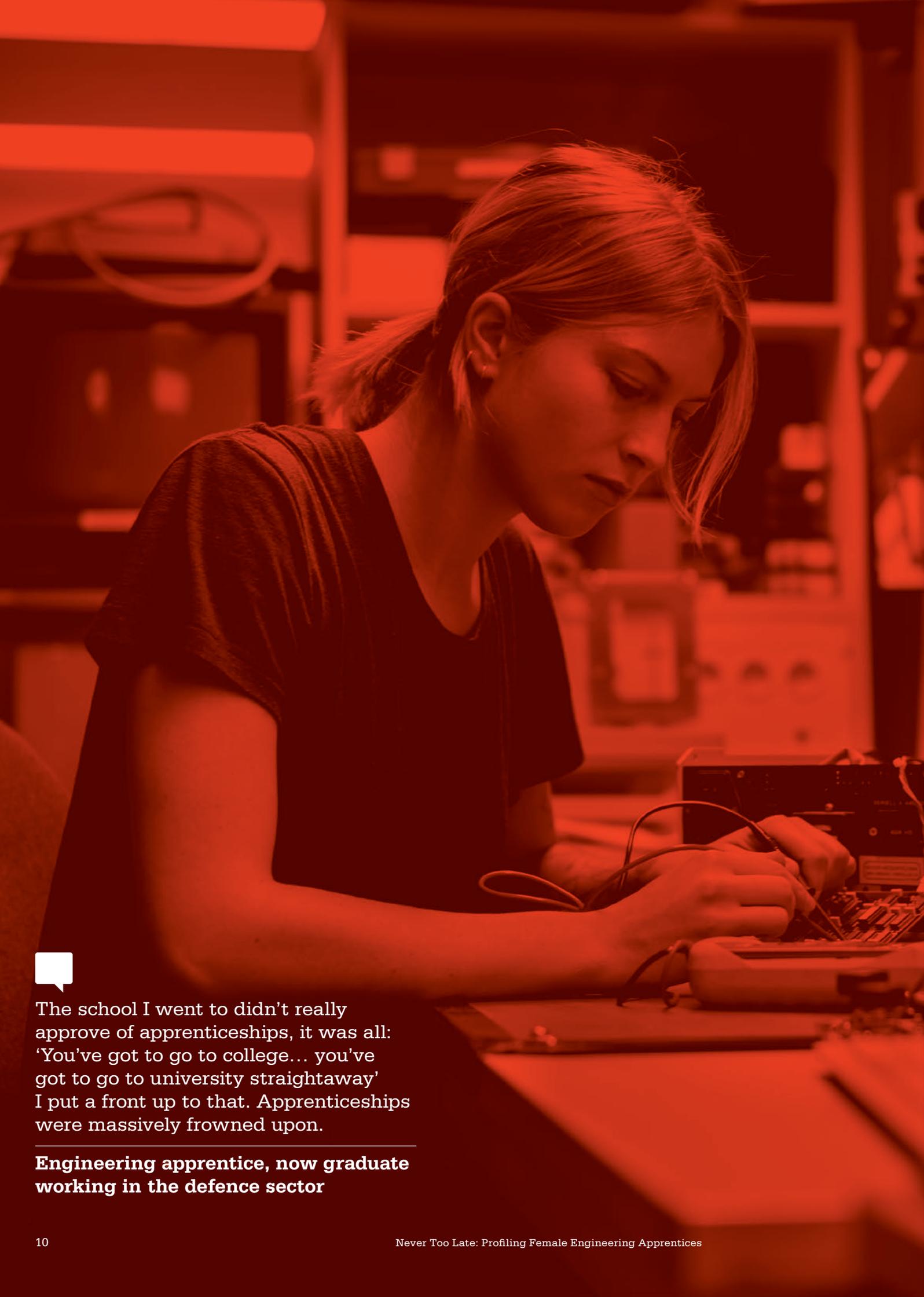
Female apprentice engineer

Female (and male) engineering apprentices have strong family-based ties to engineering.

Engineering apprentices are more likely to have had other family members working in engineering or manufacturing. Female engineering undergraduates are less likely to have family connections to engineering and are more likely to be the first to pursue an engineering pathway.

Percentage of respondents with family members who had studied or worked in engineering/manufacturing.





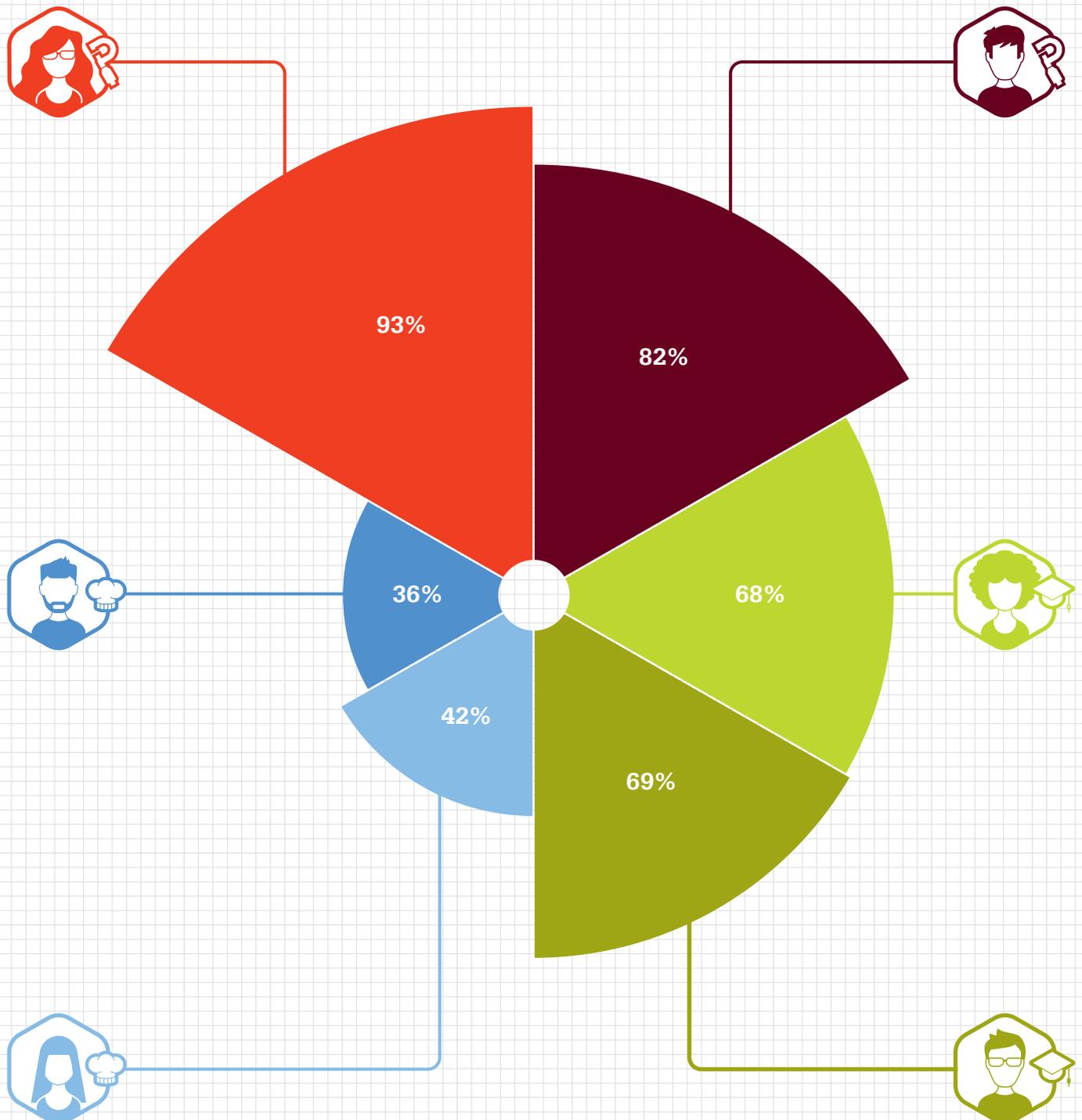
The school I went to didn't really approve of apprenticeships, it was all: 'You've got to go to college... you've got to go to university straightaway' I put a front up to that. Apprenticeships were massively frowned upon.

Engineering apprentice, now graduate working in the defence sector

Female engineering apprentices are highly debt-averse.

Like their male counterparts, female engineering apprentices, especially the latter, are uncomfortable with the idea of accumulating debt. They are also more likely to have worked before the age of 18 and less likely to believe that a university degree is needed in order to have a good career.

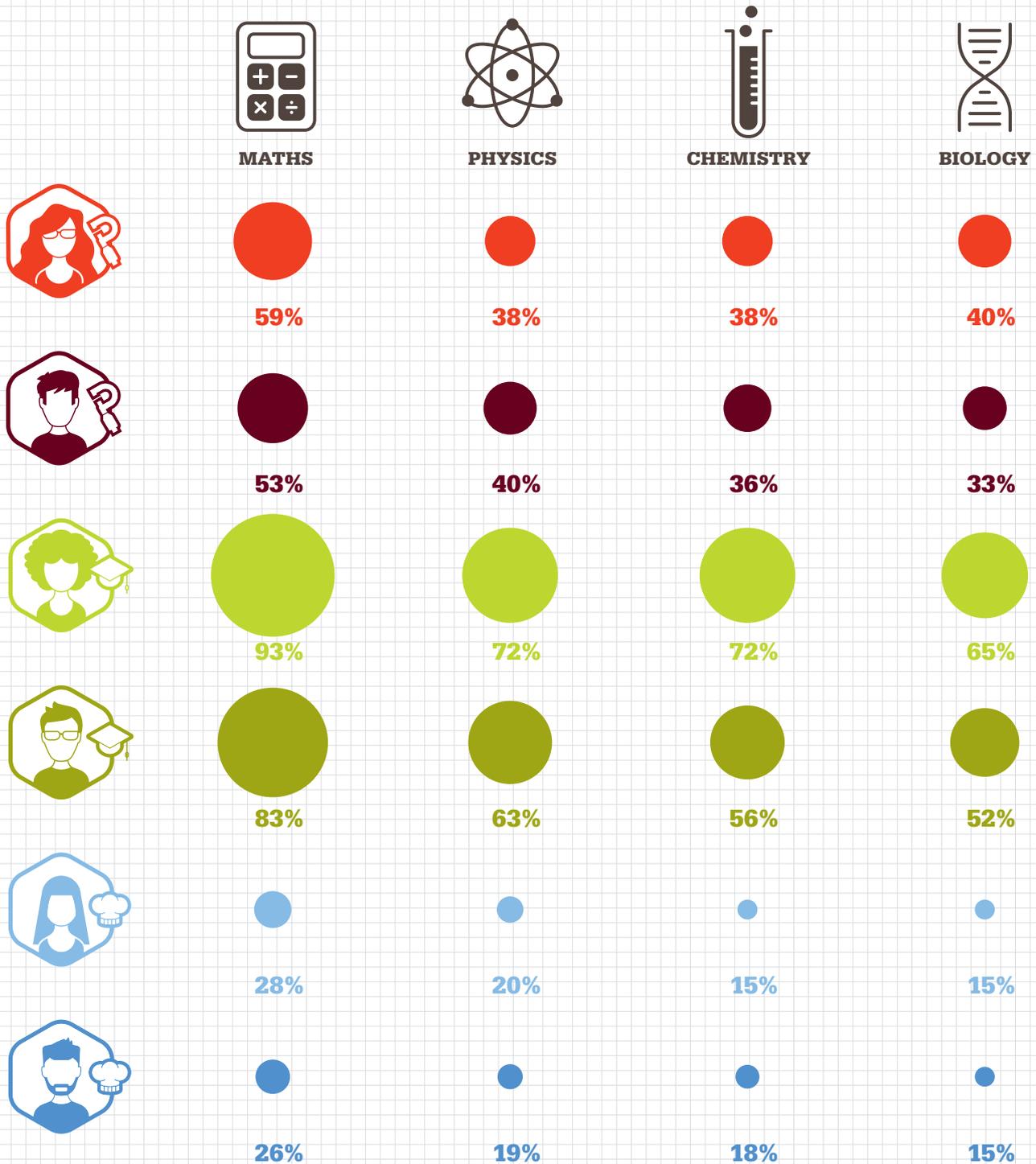
Percentage of respondents expressing discomfort with accumulating debt.



Female engineering apprentices tend to have outperformed non-engineering apprentices academically, but their school attainment was lower than engineering undergraduates.

Both male and female engineering apprentices perform reasonably well in STEM GCSEs. Female engineering undergraduates are the group with the highest academic attainment.

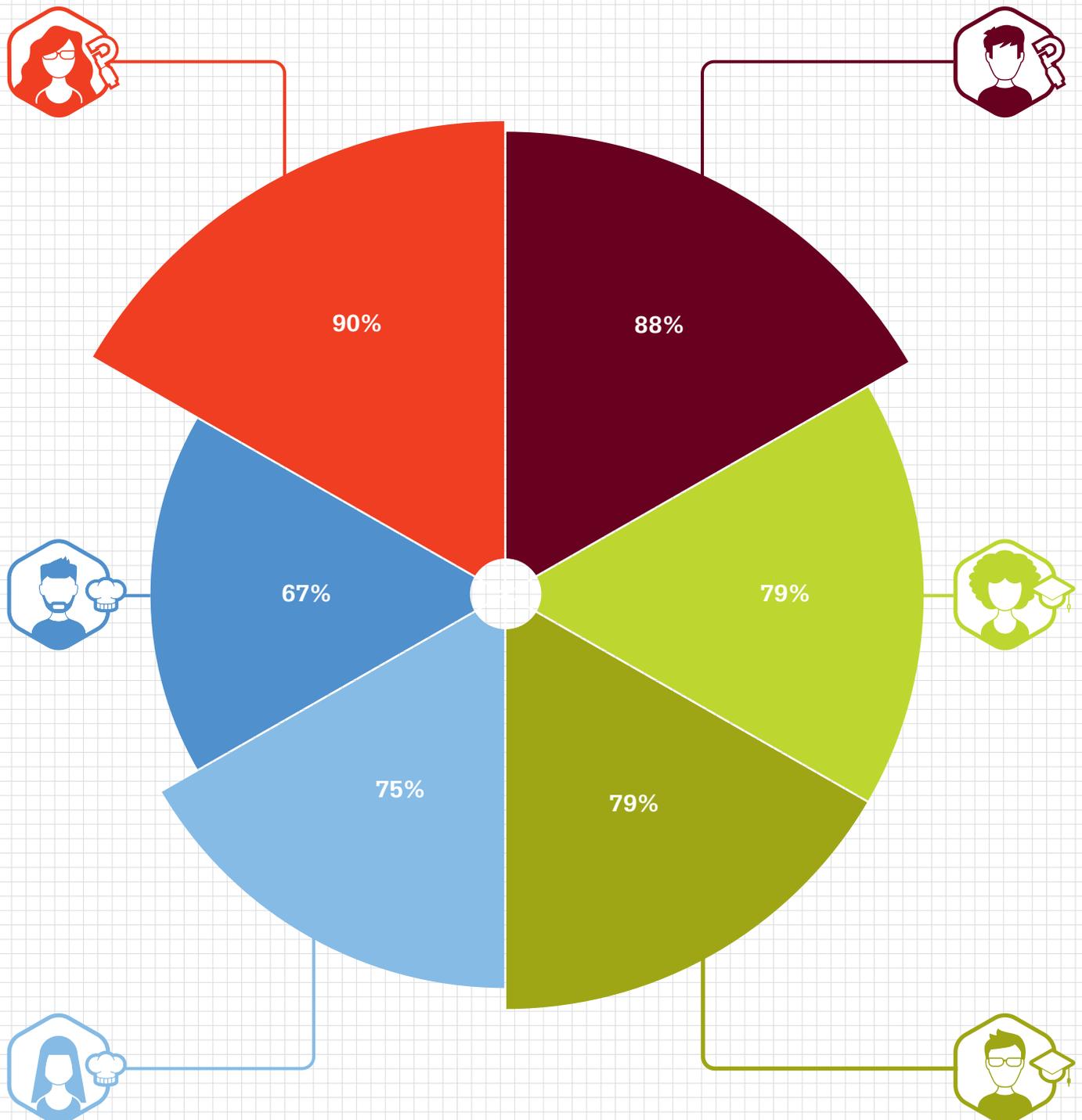
Percentage of respondents achieving GCSE grades A* or A (Analysis for GCSE only, not Scottish Standard Grade).



Female engineering apprentices prefer hands-on learning to academic study.

Both male and female engineering apprentices favour hands-on learning. Female engineering apprentices are less likely to enjoy school, less likely to enjoy learning for learning's sake, and more likely to believe they learn best through doing rather than studying.

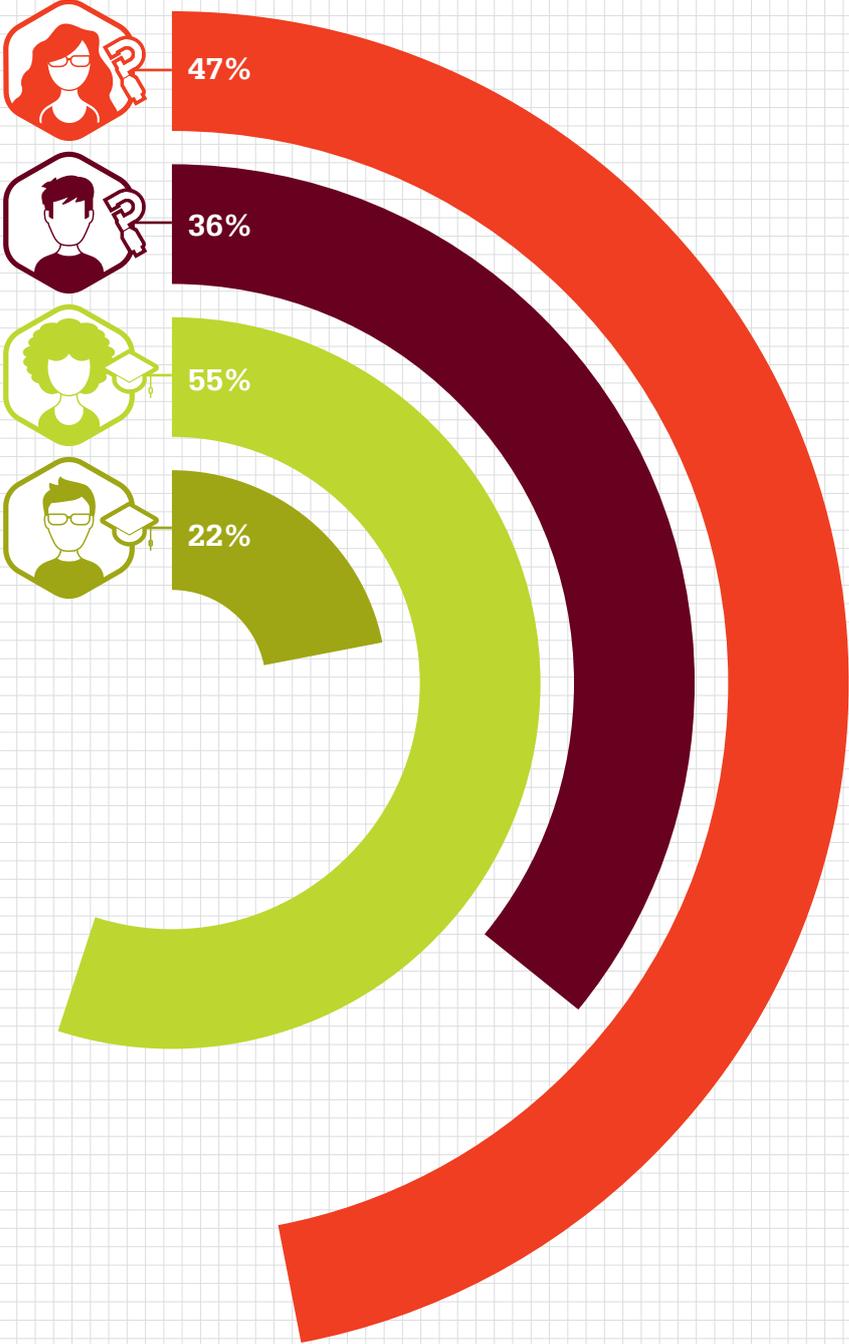
Percentage of respondents agreeing that they learn best through doing rather than studying.



Female engineering apprentices come to engineering later.

Female engineering apprentices and undergraduates are less likely than males to have had a long-term interest in engineering and engineering careers. However, they are more likely to have grown up with an interest in creative crafts.

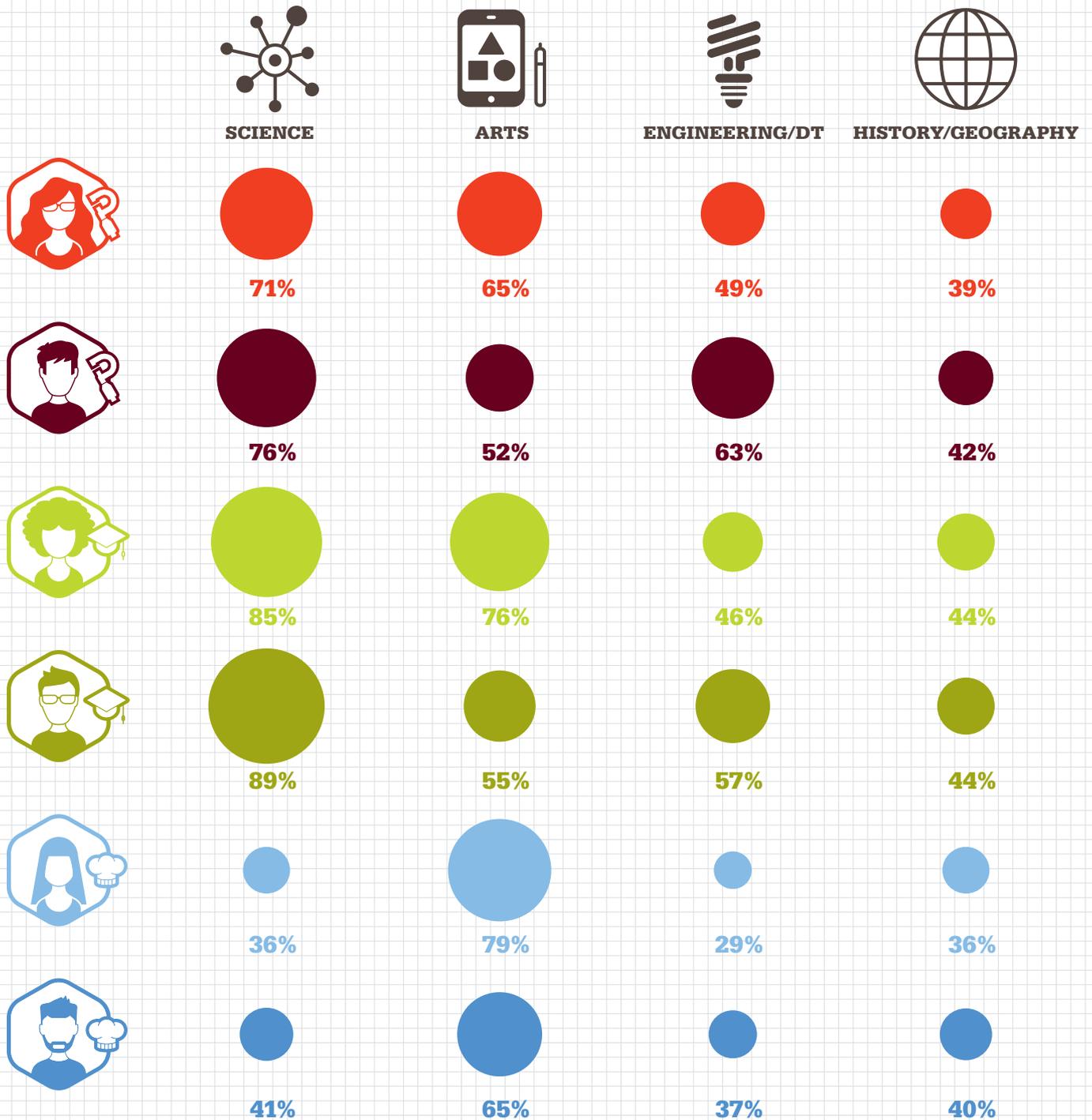
Percentage of respondents saying that they came to engineering later.



Female engineering apprentices have broad academic interests.

Female engineering apprentices are more interested than non-engineering apprentices in science subjects, but less interested than engineering undergraduates. Female engineering apprentices and undergraduates have a relatively strong interest in arts subjects but, compared to their peers, less interest in engineering/design and technology (although more interest than non-engineering apprentices).

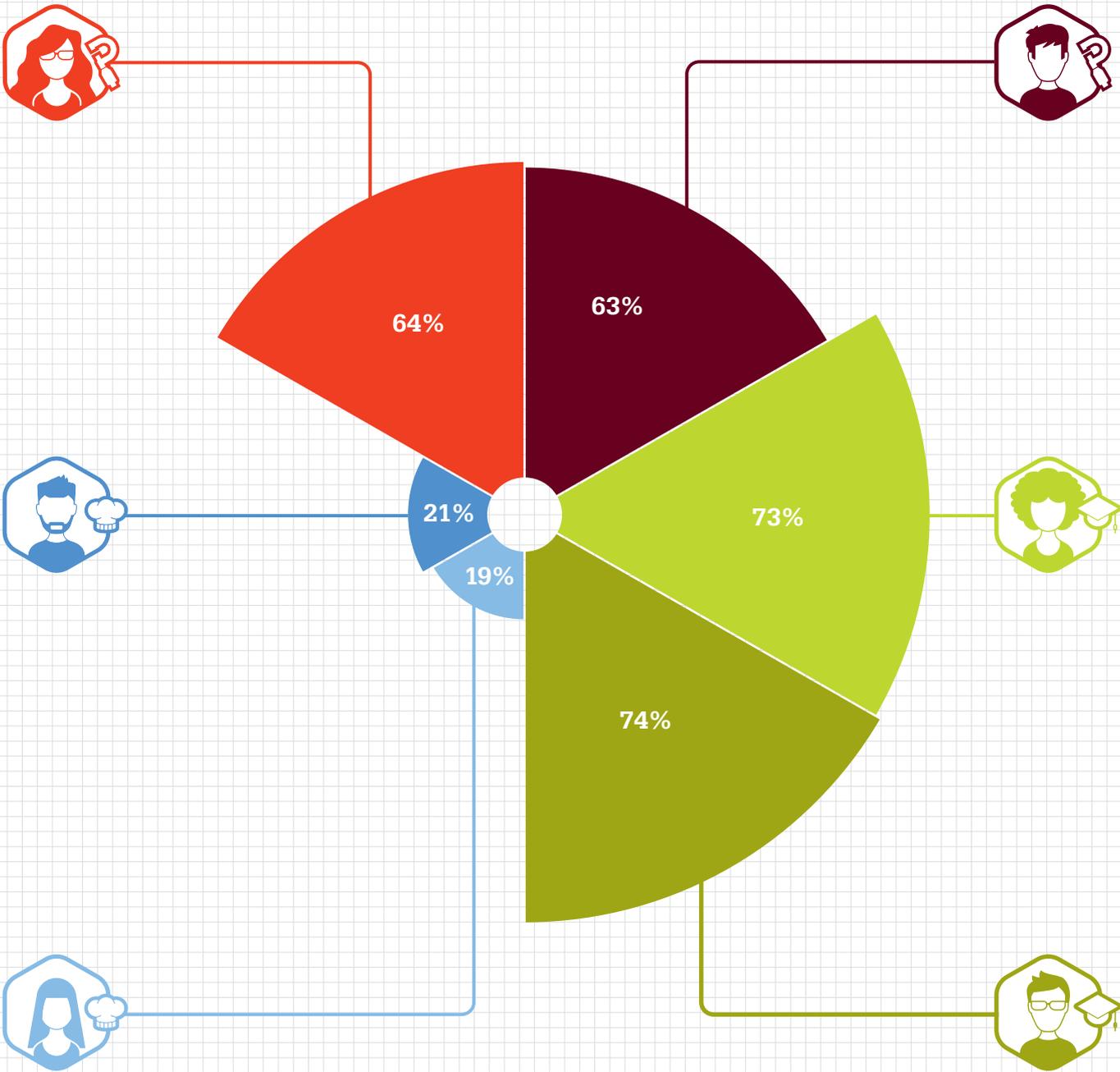
Percentage of respondents saying they enjoyed a subject at school.



Female engineering apprentices have mostly made a positive decision to pursue their career pathway.

Female (and male) engineering apprentices are less likely than non-engineering apprentices to have chosen a career path because of an absence of alternatives. They made these choices based on their own research, rather than provision of careers information in schools.

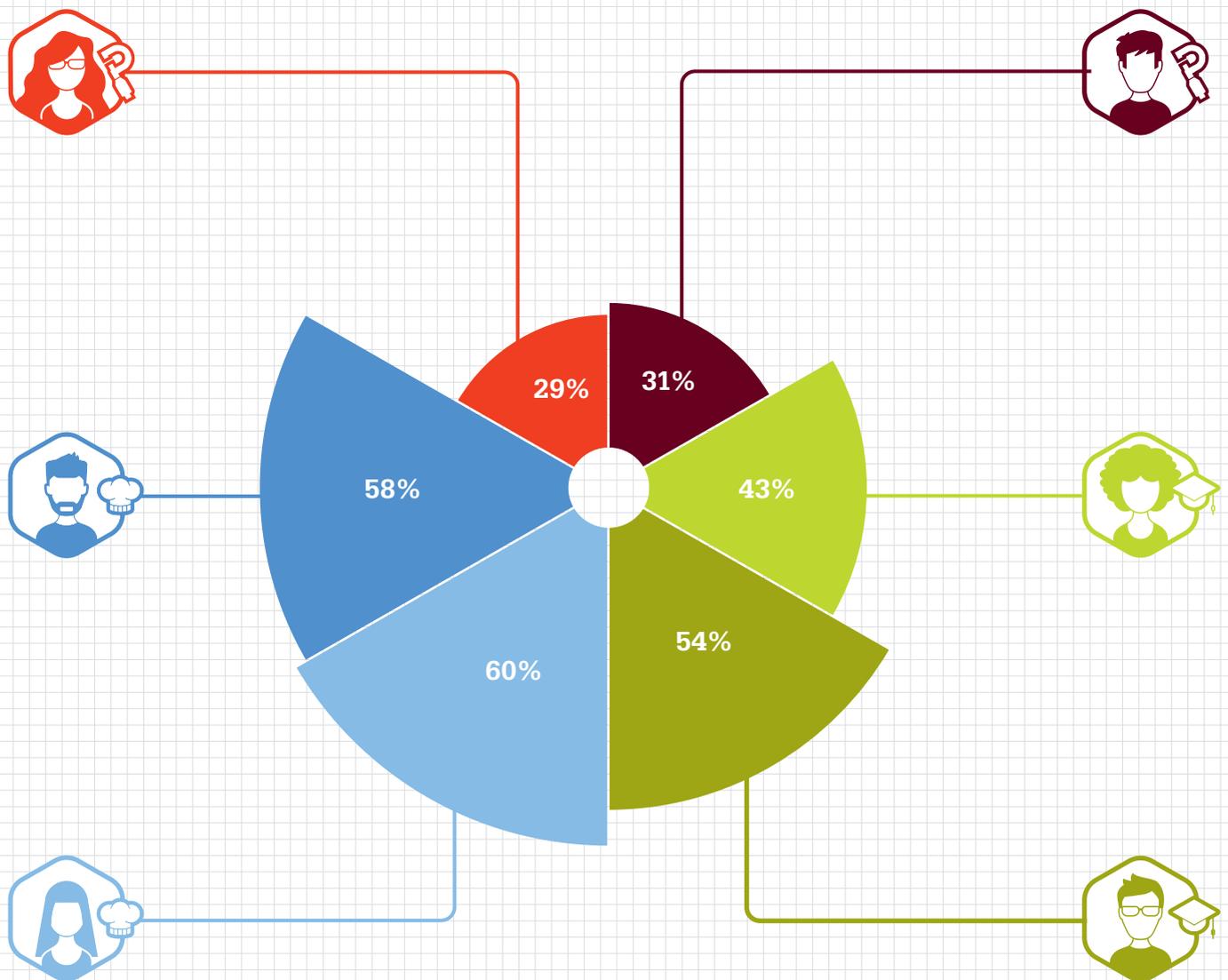
Percentage of respondents disagreeing with the statement: "I chose my route because I didn't know what else to do."



Female engineering apprentices have very negative views of careers advice provision in schools.

Female (and male) engineering apprentices do not believe that good-quality information on career options is available to students and families.

Percentage of respondents who agreed that they or their parents had access to good-quality information about future study options and a wide range of job opportunities, what they paid and the qualifications needed.





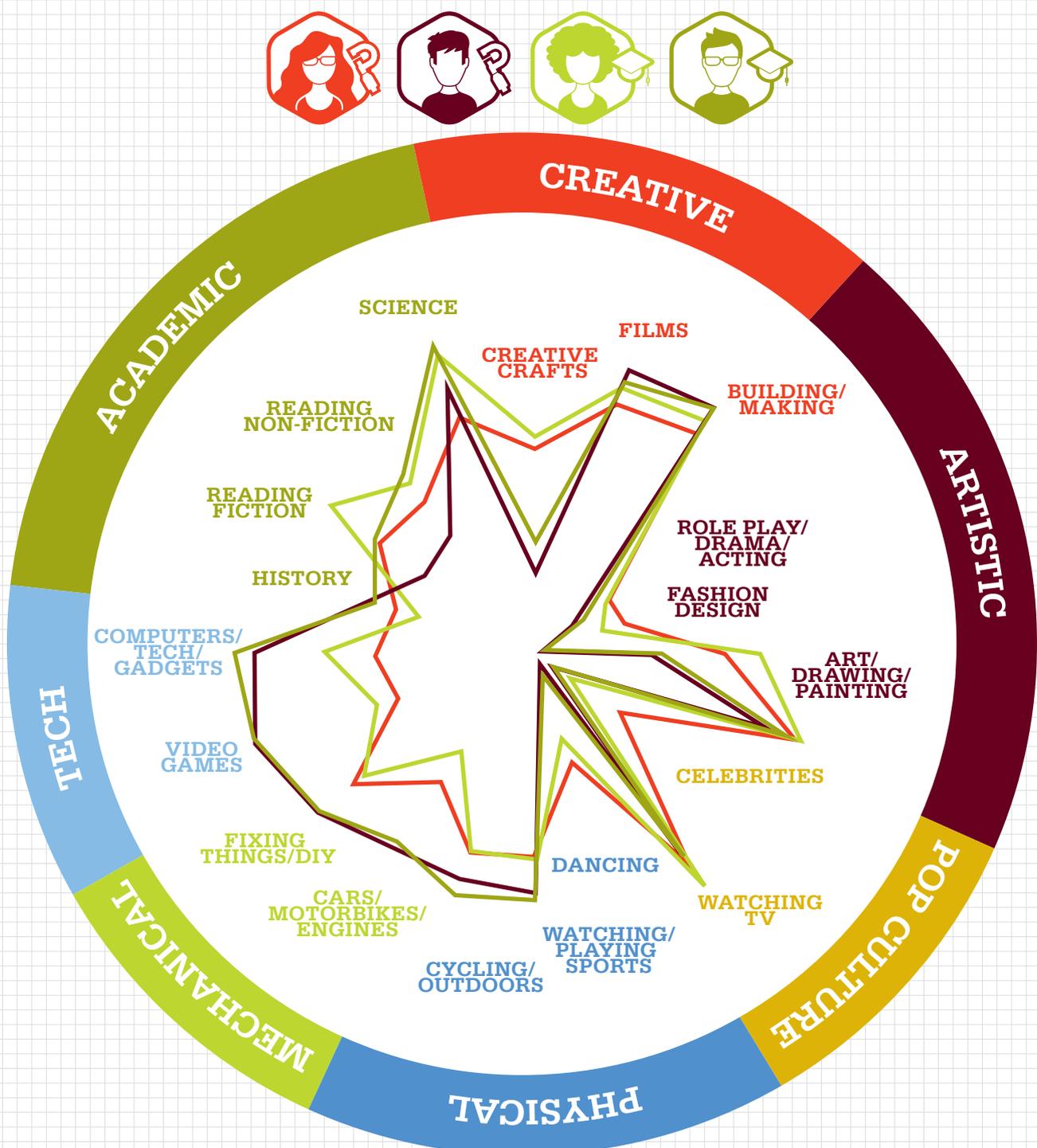
Unless the imbalance in apprenticeships is addressed, we face a significant risk of the apprenticeship programme further exacerbating the gender bias within the engineering and manufacturing technologies sector, rather than providing opportunity for women and men alike.

Dr Fiona Aldridge
Assistant Director
Research & Development
Learning and Work Institute

Female engineering apprentices have a stronger interest in creative and artistic activities and lower interest in technical pursuits.

Female engineering apprentices and undergraduates are more likely than their male peers to be interested in creative crafts, and artistic activities and less likely to favour technology and 'tinkering'.

Comparison of hobbies and interests growing up; distance from centre corresponds to numbers in each group with an interest in the areas indicated.



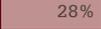
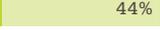
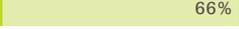
MAIN FINDINGS: SEGMENTATION OF ENGINEERING TYPES

Drawing on preliminary research and previous studies, respondents were asked their level of agreement with a range of statements exploring their beliefs, attitudes and values. Their statements were designed to enable researchers to identify personality profiles, based on clusters of answers.

The segmentation analysis of engineering apprentices and undergraduates identified four segments:

- Ambitious Aspirers
- Persistent Pragmatists
- Intellectual Independents
- Accidental All-rounders

Table 1: Engineering types by study/training mode and gender

	Segment	Segment Breakdown
	Ambitious Aspirers – Studious yet practical	Apprenticeship  37%  63% University Female  22%  78% Male
	Persistent Pragmatists – Practical problem solvers	Apprenticeship  72%  28% University Female  25%  74% Male
	Intellectual Independents – Free-thinking theorists	Apprenticeship  41%  59% University Female  27%  73% Male
	Accidental All-rounders – Creative and open	Apprenticeship  56%  44% University Female  33%  66% Male

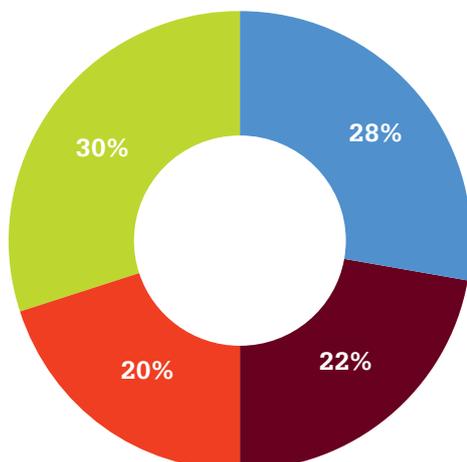
Female engineering apprentices can be found in all groups, but are over-represented in the Accidental All-rounders and Persistent Pragmatists segments.

Table 2 provides a brief summary of the traits associated with each segment.

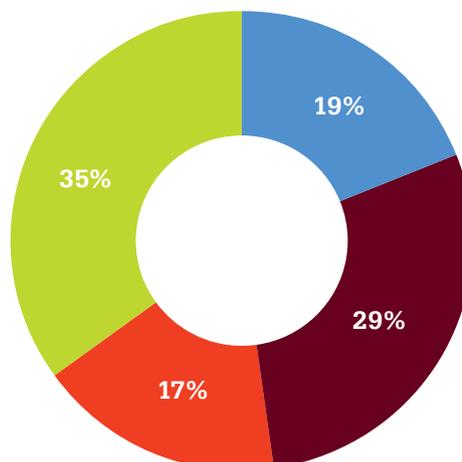
Table 2: Emerging traits for each engineering type

	Segment	Segment Characteristics
	Ambitious Aspirers	<ul style="list-style-type: none"> — Loved school, especially STEM subjects — Believe in university — See university as the natural path — Have a long-standing interest in engineering careers — Keen to start working
	Persistent Pragmatists	<ul style="list-style-type: none"> — Least likely to enjoy school — Not convinced that university education is key to good career — Have family connections to engineering — Committed to hard work to progress
	Intellectual Independents	<ul style="list-style-type: none"> — Love to learn, often for its own sake — See engineering as an intellectual challenge — Free-thinkers about career options — Consider multiple viewpoints in decision-making
	Accidental All-rounders	<ul style="list-style-type: none"> — Less STEM-focused — Stumbled upon engineering relatively late — Keen on a good work-life balance — Value creativity — In touch with their feelings

Proportion of engineering types across all engineering graduates and apprentices



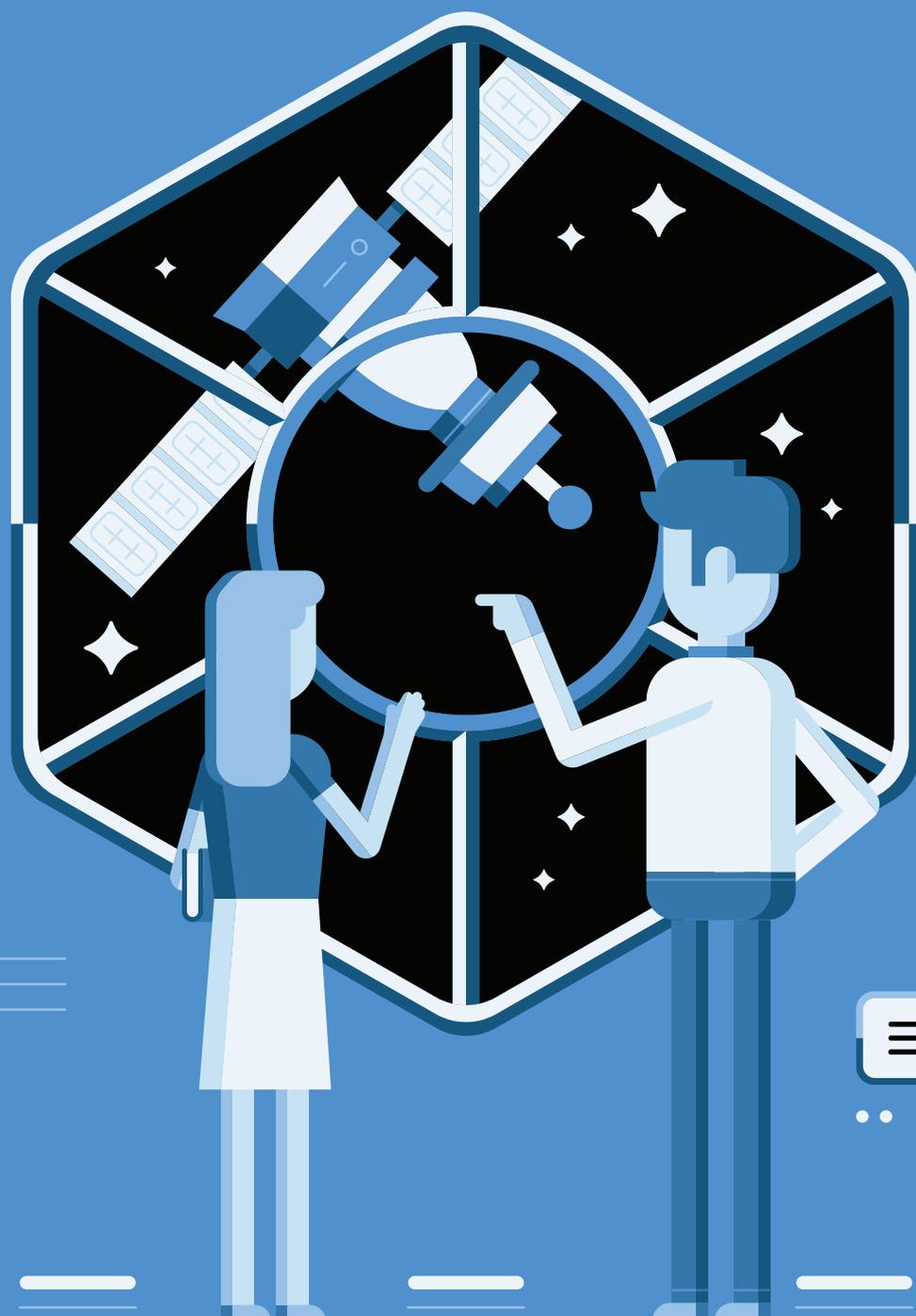
Proportion of engineering types for female apprentices only



AMBITIOUS ASPIRERS



- Loved school, especially STEM subjects
- Believe in university
- See university as the natural path
- Have a long-standing interest in engineering careers
- Keen to start working

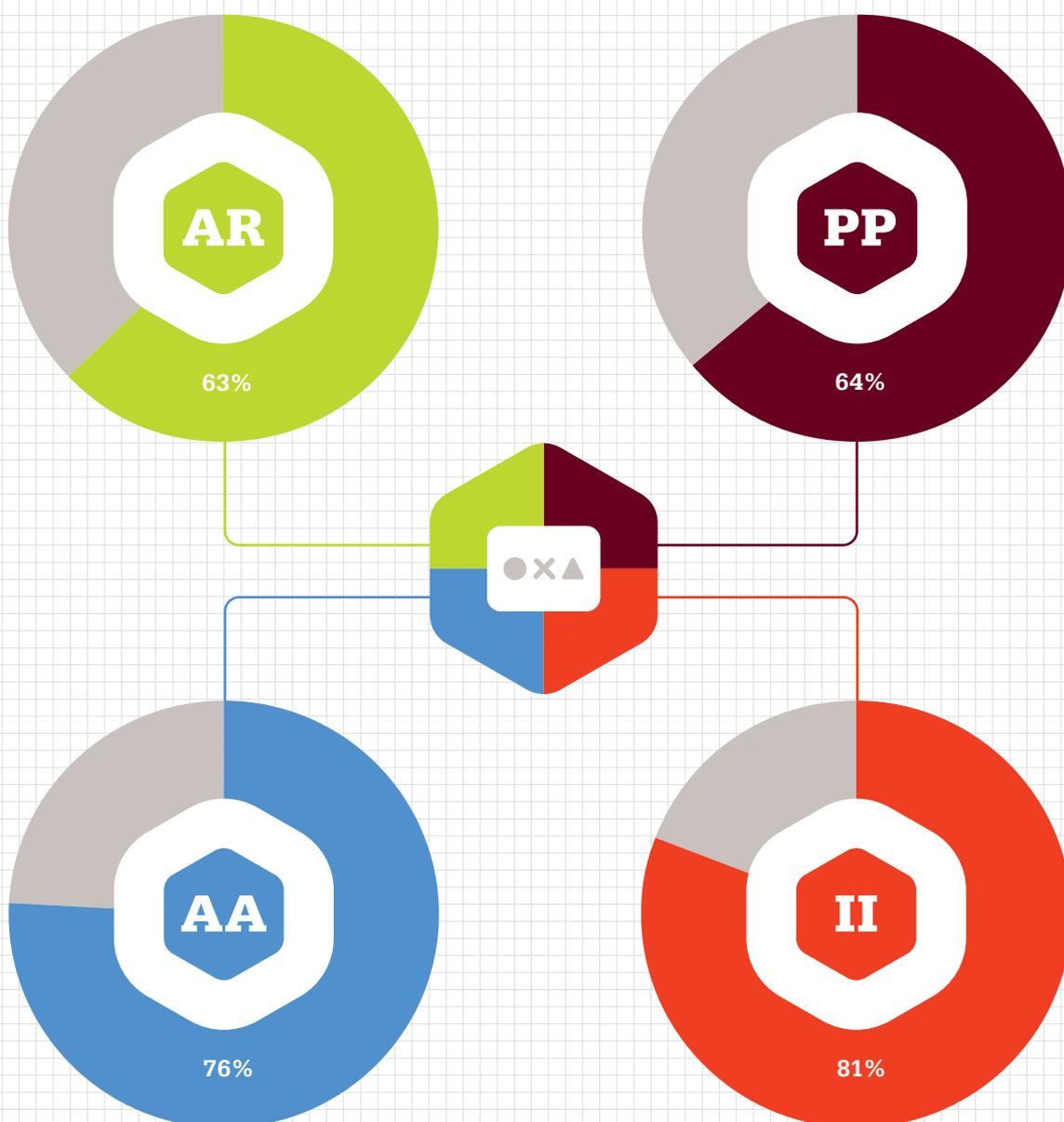


Accidental All-rounders and Persistent Pragmatists are less likely to enjoy learning for learning's sake.

Ambitious Aspirers and Intellectual Independents are strong believers in learning for learning's sake.

- AA Ambitious Aspirers
- II Intellectual Independents
- PP Persistent Pragmatists
- AR Accidental All-rounders

Percentage of respondents agreeing with the statement: "I enjoy learning for learning's sake."



PERSISTENT PRAGMATISTS

PP

- Least likely to enjoy school
- Not convinced that university education is key to good career
- Have family connections to engineering
- Committed to hard work to progress

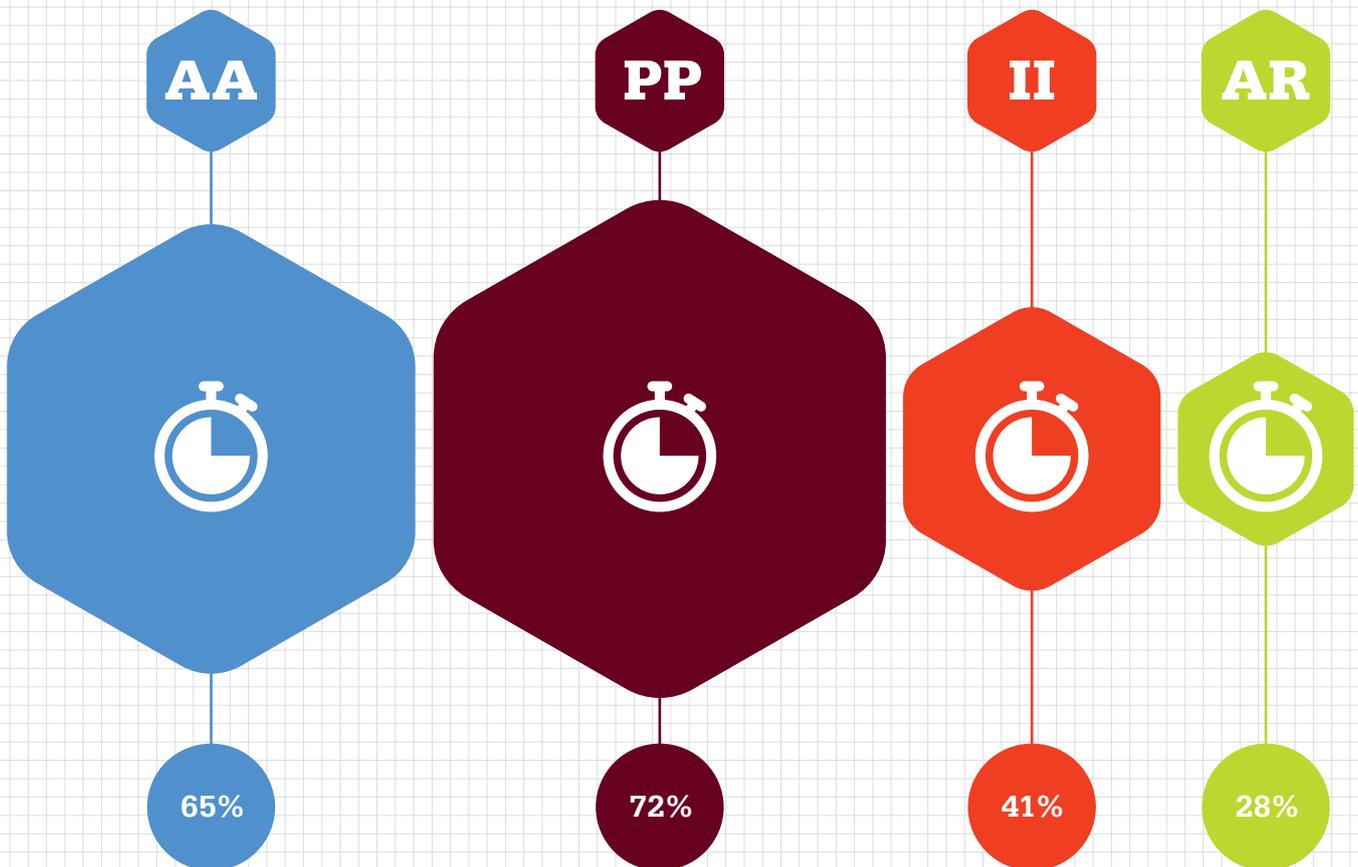


Accidental All-rounders come to engineering late on.

Accidental All-rounders are the group least likely to have decided at an early age that they wanted to pursue engineering.

- AA** Ambitious Aspirers
- II** Intellectual Independents
- PP** Persistent Pragmatists
- AR** Accidental All-rounders

Percentage of respondents agreeing with the statement:
"I knew from an early age that I wanted to go into engineering."

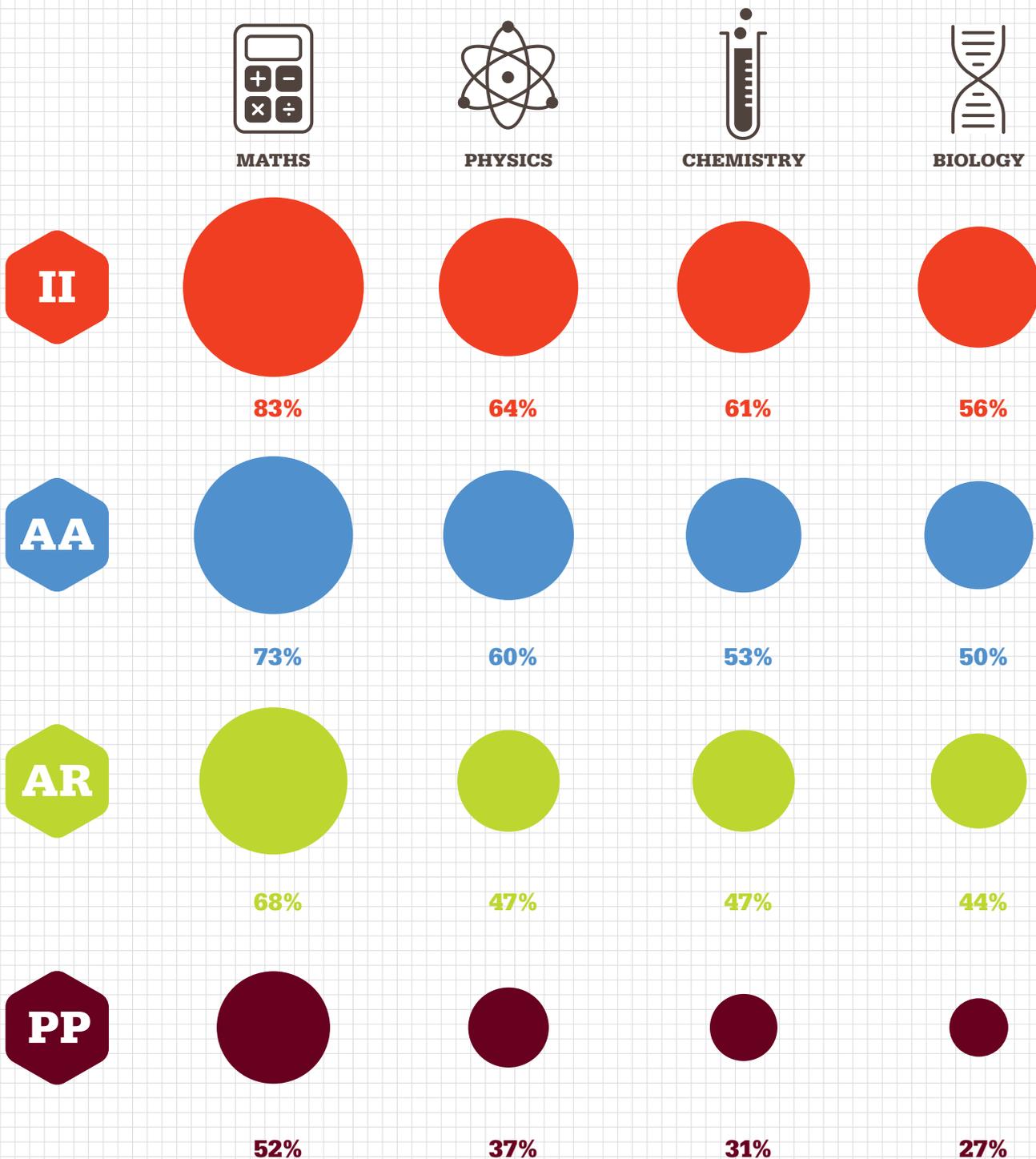


Accidental All-rounders are middle ranking academically.

The Ambitious Aspirers and Intellectual Independents segments include many graduates and show high academic achievement; Accidental All-rounders outperform Persistent Pragmatists.



Percentage of respondents achieving A*/A in the indicated subjects (excluding respondents from Scotland).

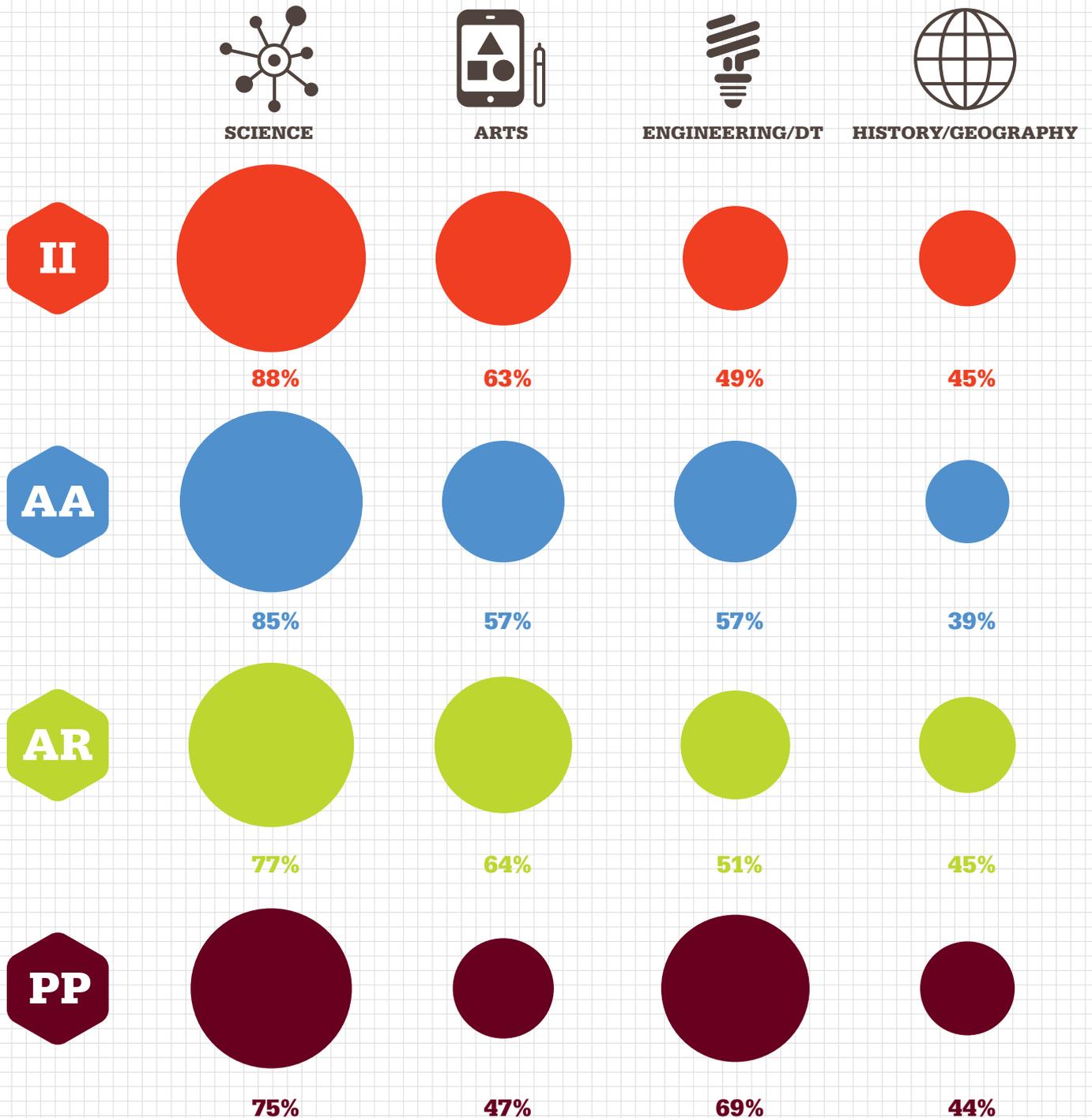


Accidental All-rounders have broad academic interests, including the arts as well as science.

Science is popular among all groups, but Accidental All-rounders (and also Intellectual Independents) have an interest in the arts. Persistent Pragmatists have the strongest interest in engineering/design and technology.

-  Ambitious Aspirers
-  Intellectual Independents
-  Persistent Pragmatists
-  Accidental All-rounders

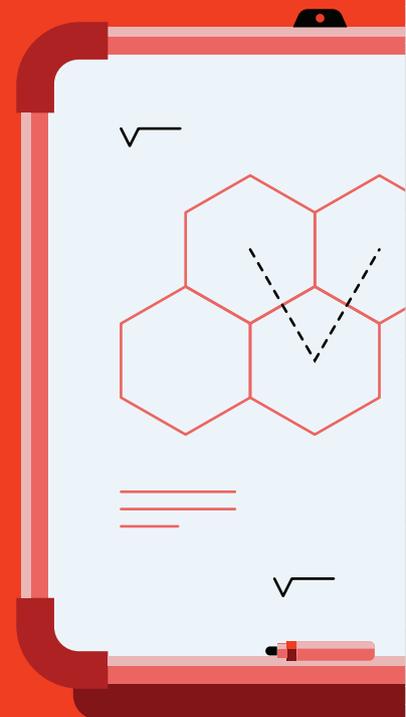
Percentage of respondents saying that they enjoyed the indicated subjects at school.



INTELLECTUAL INDEPENDENTS

II

- Love to learn, often for its own sake
- See engineering as an intellectual challenge
- Free-thinkers about career options
- Consider multiple viewpoints in decision-making

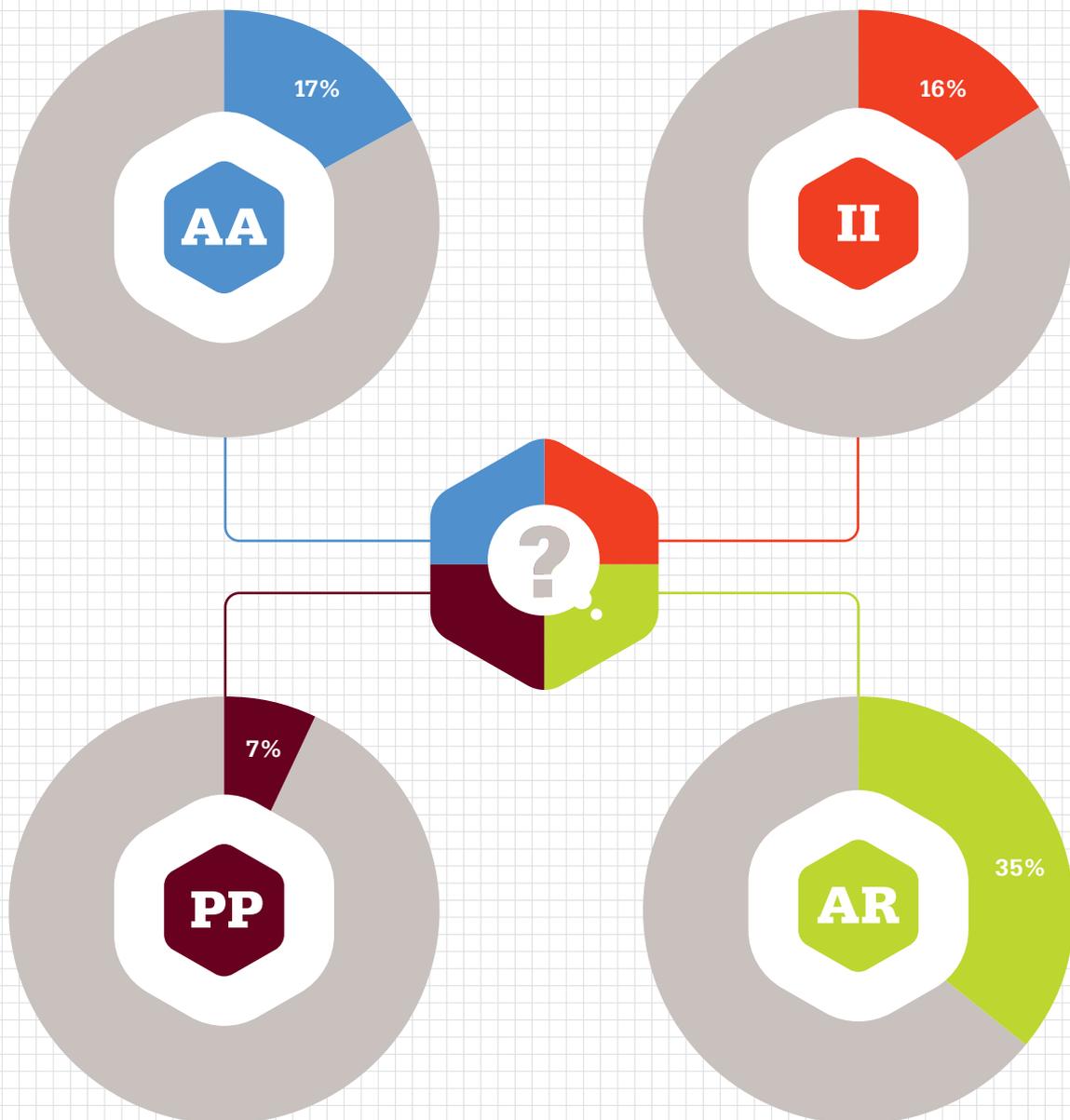


Persistent Pragmatists are those most set on engineering.

Persistent Pragmatists are the least likely to say they chose a course because they were not sure what else to do; Accidental All-rounders showed much less early interest in engineering.

- AA** Ambitious Aspirers
- II** Intellectual Independents
- PP** Persistent Pragmatists
- AR** Accidental All-rounders

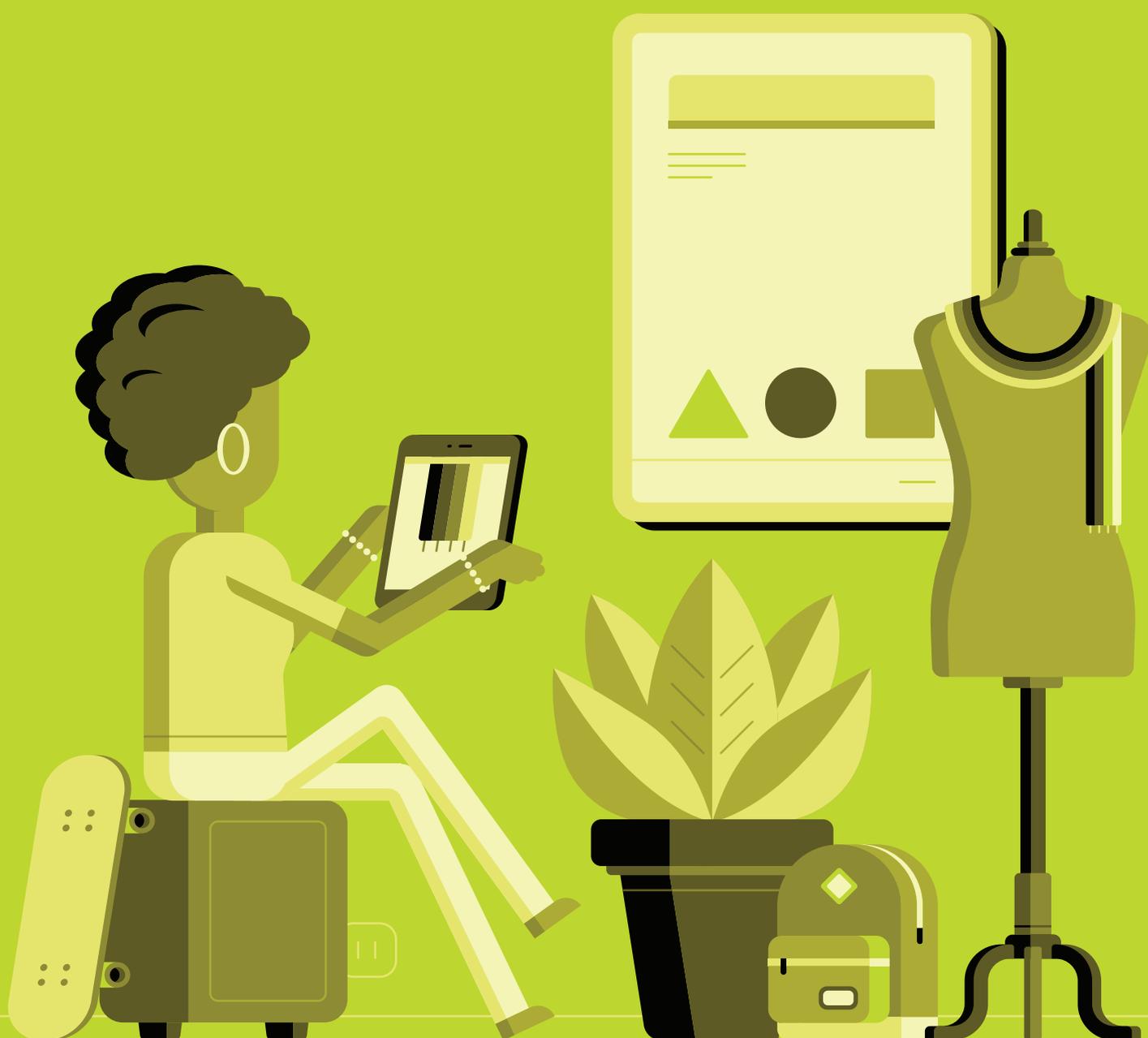
Percentage of respondents agreeing with the statement: "I chose my course/apprenticeship because I didn't know what else to do."



ACCIDENTAL ALL-ROUNDERS

AR

- Less STEM-focused
- Stumbled upon engineering relatively late
- Keen on a good work-life balance
- Value creativity
- In touch with their feelings

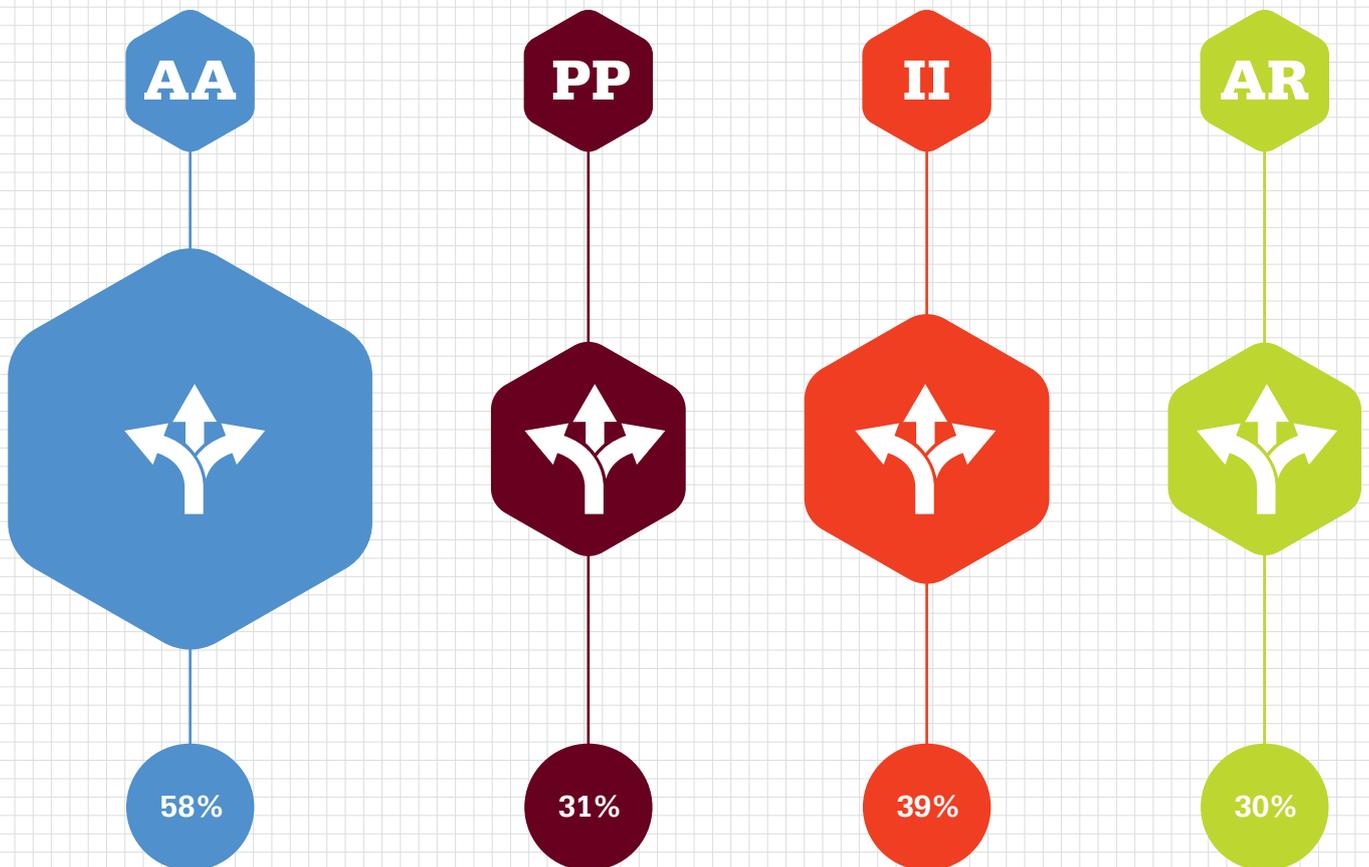


Ambitious Aspirers are the most positive about the provision of careers advice in school.

Other groups, particularly Accidental All-rounders, have poor perceptions of careers advice provision.

- AA** Ambitious Aspirers
- II** Intellectual Independents
- PP** Persistent Pragmatists
- AR** Accidental All-rounders

Percentage of respondents who agreed that they and their parents had access to good-quality information about future study and a wide range of job opportunities, what they paid and the qualifications needed.





CONCLUSION

The survey and segmentation analysis have provided important new insight into female engineering apprentices and how they compare with their male peers, female engineering undergraduates and non-engineering apprentices. Although female engineering apprentices are something of a rarity, there is no evidence that they are 'a breed apart', suggesting that the UK school population may include many more females who could be attracted to this career route, given the right opportunities.

The survey data suggests that female engineering apprentices are typically down-to-earth, practically minded individuals who have generally held jobs before the age of 18 and are keen to start working their way up the employment ladder. They are notably debt-averse, which has a significant influence on their decision to choose an apprenticeship over university, and they do not see a degree as the only way to achieve a good career.

Although their academic achievements do not match those of undergraduates, they significantly outperform non-engineering apprentices. They are the group least likely to have enjoyed school and most likely to say they learn best through doing rather than studying. However, they have relatively wide academic interests, sharing with female undergraduates a relatively strong interest in arts subjects (and for creative craft activities) but a lower regard for engineering/design and technology than males.

Family connections to engineering/manufacturing appear to be particularly significant for apprentices of both sexes. Female engineering apprentices discovered most of the information about their courses from their own research, and had the lowest opinion of schools career provision, pointing to a serious deficit of apprenticeship-related advice in schools.

Notably, both female engineering apprentices and female engineering undergraduates often settled on engineering relatively late, compared with their male peers. This suggests that females are less likely than males to be 'hobbyists' with a long-standing interest in engineering, but identify it as a suitable career route when considering their potential career destinations. Concerns that girls are being turned off engineering early in life have led to a significant focus on promotional initiatives targeting primary school and early secondary school. These results suggest that there may also be an important window of opportunity at later stages of schooling, when girls might be receptive to the right kind of engineering-related careers information.

The segmentation analysis identified four distinct groups. Female engineering apprentices were spread across all four segments, again highlighting the fact they are not a distinctly unusual group. However, they were slightly over-represented in the Accidental All-rounders and Persistent Pragmatists segments. Individuals in the latter category have typically identified engineering-related career routes relatively early in life. This group could be considered to include individuals showing a strong and early inclination to pursue engineering career routes.

The Accidental All-rounders – who made up nearly one in three of the sampled population – were more likely to arrive at engineering career routes relatively late and without many of the traits traditionally associated with would-be engineers.



DISCUSSION

Understanding why some women choose to train as engineering apprentices is not straightforward. The very nature of the challenge means that numbers are small, and the core assumption that the personality traits of those who have become engineers can be applied to those who have not is untested. Nevertheless, this study shows that women who choose engineering are not easily typecast. This is both good and bad news. It means that the potential talent pool is larger than otherwise imagined; on the other hand, it makes targeting of interventions more challenging. Even so, despite the absence of a discrete easy-to-target group, identifying and then catering for academically able and practically minded young women with interests in creative crafts and arts-related activity, may be an approach worth considering. There are, of course, some girls and young women who have had their hearts set on engineering from an early age, but this group is smaller than the equivalent group of young men.

With a drive to intervene with messaging about engineering at an increasingly younger age, engineering careers organisations may also wish to explore how to engage 15–25-year-olds with a dedicated set of audience-appropriate messages. The evidence from this study suggests that even at these late stages, there is a chance to convince young women of the benefits of engineering apprenticeships and that it is not too late to persuade them.

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