‘People like me’: identifying personal attributes of STEM professionals

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***Abstract*— This Full Paper presents the findings from a study to identify the attributes STEM professionals believe make them successful in their role. Engineering and other STEM employers indicate that they value transferable skills linked to personal characteristics and attributes, often called soft skills. These attributes of STEM professionals were also compared with a separate set of 16 STEM attributes developed for use in STEM engagement interventions for children and young people. A snowball sample of self-identified STEM employees was gathered (n=217), with the majority of respondents from the North East of England (54%). Using an online survey participants named up to six personal attributes and were asked to rate how well the 16 STEM attributes described them. Thematic analysis identified 19 different themes with soft skills contributing 68% of the terms provided. This research provides a clear indication that soft skills are valued by established employees in their work. It also indicates that there is merit in looking beyond subject knowledge to frame engineering education and engagement activities. The 16 STEM Attributes in the STEM engagement interventions were found to realistically represent the attributes of those working in STEM. An attributes based approach to engagement could help children and young people to identify the skills that they have (or could develop), or support students with employability by enabling them to elucidate the value of their own skills to the employer.**

Keywords—soft skills, attributes, STEM professional, STEM engagement

I. INTRODUCTION

The workplace and global jobs market in the 21st century continues to change, with a stronger focus by employers on employability skills over technical skills [1] [2]. For example, in the UK Ernst and Young removed academic entry requirement for their ‘graduate programme’ [3]. Whilst traditional graduate programmes continue to be important routes into many large organisations [4][5], the need for future employees to have a broad range of non-technical skills as well is clear [6].

A. *Hard and soft skills*

These non-technical employability skills [7] are often called ‘soft skills’ [8][9] with exact definitions varying according to sector or employer [10][11], but are generally thought to encompass people skills, communication skills, and the ability to manage oneself. Previous research has explored the nature of these desired skills from the viewpoint of employers (see e.g. [12] [13] [7]), engineering undergraduates [14][15] and those already in work [9]. A systematic review [16] of 43 studies of employability skills identified ten broad skills sets seen across the studies in a range of different (STEM and non-STEM) employment sectors and countries. These included interpersonal and collaborative skills (41 out of 43 studies), relationship management skills (39 studies), cognitive and problem-solving skills (33 studies), and productive self-management skills (31 studies). Ref. [17] building on previous work by [18] identified a list of 26 competences which were defined either as hard skills linked to (technical) aspects of a role which can be learnt, or soft skills which are more behavioural and potentially seen as inherent in an individual [19].

Engineering, along with other STEM sectors, has also identified the importance of soft skills [20][21]. Increasingly, engineering focussed job adverts include references to a range of soft skills [22][23]. The demand from employers for these skills is leading to changes within engineering degrees to support future graduates to develop them [24].

B. *Addressing the shortage of STEM Employees*

Another issue facing engineering and STEM sectors is a shortage of STEM employees and a lack of diversity within the current STEM workforce [25]. This has led to a large number of organisations providing STEM engagement activities to children and young people [26]. Many of the stated aims of these activities are similar e.g. “inspiring the next generation of engineers and scientists” [27, 3rd para].

However, some interventions have taken a different approach. The ‘People Like Me’ project, uses an attribute-led approach which emphasises “…the ‘types of people’ that are happy and successful in a wide variety of jobs and careers using a STEM qualification…” [28, p.3]. The intervention included a list of 43 positive adjectives (such as friendly, organised, logical, eloquent) and combinations of these adjectives were linked to 12 different types of roles in STEM [28].

This move towards helping students to identify with those who work in STEM is supported by science capital research [29] which has consistently shown that the majority of students enjoy science but do not aspire to a career in science or other STEM fields.

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The current paper extends previous studies, which generally focussed on employers or students, by identifying the employability skills of current professionals in STEM.

II. Background

The current study took place within the context of an outreach group based at a university in the North East of England. Their aim is to increase the diversity of STEM sectors through working with key stakeholders to broaden students' career aspirations. The outreach group works with around 40 schools, both elementary (ages 3 – 11) and high (ages 11 – 18). As part of this work, the group develops resources that teachers can use to introduce careers into their classroom teaching.

The outreach group developed of a set of 16 STEM attributes: Collaborative, Committed, Communicator, Creative, Curious, Hard-working, Imaginative, Logical, Observant, Open-minded, Organised, Passionate, Patient, Resilient, Self-motivated, Tenacious. These attributes were chosen following a review of literature [28] [30] and finessed through discussion with elementary school science teachers and staff at the Institute of Physics. The discussions with teachers centred around the characteristics that their schools were looking to inculcate in their students, such as resilient and hard-working. Through these discussions, the 16 words were confirmed as being suitable for use with children aged 5 – 11, albeit with appropriate support from an adult at younger ages.

These 16 STEM attributes were incorporated into a wide range of activities by the outreach group including 'STEM Person of the Week' (described more fully in [31]), classroom workshops, family home activities, and the Primary Careers Tool[1] (an online database of jobs sorted by science and maths topics studied by children aged 5 – 11 in England).

As highlighted earlier, there have been a large number of studies looking at attributes (soft skills) engineering employers would like their employees to have, and those required by new graduates, but there have been fewer studies of those in their mid- or late engineering and STEM careers [9]. This study adds to the literature by exploring the self-identified attributes amongst those already established as Engineering and STEM professionals. In addition to exploring the self-identified attributes of STEM professionals, this study also seeks to investigate if the 16 STEM attributes used by the outreach group are indeed attributes that would be used by STEM professionals to describe themselves.

III. Methodology

A. *Research questions*

This study addresses three related research questions:

- RQ1: How do STEM professionals describe the attributes they have which make them successful in their role?
- RQ2: Do the attributes of STEM professionals vary depending on gender, age and educational background?
- RQ3: Do the STEM professionals' attributes correlate with the STEM Attributes used by the outreach group?

These research questions were approached using a broadly quantitative methodology which allowed the researchers to gather data from a broad range of individuals. The research instrument was an online survey distributed via professional STEM organisations and social/professional online networks to individuals who considered themselves to be STEM professionals. The survey was open for 4 weeks, with a reminder email sent to the distributing organisations half-way through the time. Each participant created a seven character code to provide anonymity, but also to allow removal of data from the survey at a later date.

The survey consisted of a mixture of free-response, Likert scale and demographic questions. Participants were first asked to describe in an open question up to six attributes that they would '*describe yourself as having that you feel are essential to being successful in your role'* . They were then asked to rate how well a list of 16 STEM Attributes described them as a professional using a five point Likert scale (1 - strongly disagree to 5 – strongly agree). A simple definition of each attribute was included in the question. Finally demographic information about age, gender (obtained via free text response), highest education level achieved, job title and sector, seniority, and geographical location was gathered.

An iterative phronetic analysis approach [32] was taken to the free response attributes text. This type of analysis is similar to grounded theory approach but allows literature and research interests to shape the interpretation of data in an iterative manner.

First, the free-response text answers were analysed to group very similar terms e.g. the responses communication skills, communicate well and effective communicator were merged/grouped into a single term communicator. The research team then carried out a physical thematic analysis of the unique terms obtained following the initial sorting to identify emerging themes from the data.

Next, the emerging themes were examined in light of the 16 STEM attributes and further thematic analysis undertaken. Finally, contentious terms were discussed by the whole research team until consensus about which theme they belonged to emerged from the discussion. Secondary cycle coding was then carried out by the lead author to produce a final set of themes which represented the attributes identified by the participants. The themes, and terms contained therein, were also classified as soft or hard skills, following Pang et al. [17].

Frequency statistics for age and level of qualification were obtained and compared with regional data compiled by the Office for National Statistics.

The data analysis uses a binary definition of gender (M/F), but the authors recognise that some participants did not wish to be included in this binary definition, as identified using the free-response text. Due to the small number of respondents in this category, they were not included in the analysis of association between gender and role. Associations between gender and role and each attribute was therefore treated as 2 x 2 contingency tables and therefore analysed using a phi test to ascertain directionality of association.

Due to multiple categories in the variables "age" and "qualification level" these associations were analysed using

[1] https://nustem.uk/primarycareers/

Cramer's V test, with visual inspection of frequency data to further explore identified associations. The null hypothesis in each case was that there was no association between an attribute and demographic characteristic under investigation. Levels of association were assigned as none (0.00 to 0.19), weak (0.2 to 0.39), medium (0.4 to 0.69) and strong (0.7 to 1) following [33]. Exact significance values were calculated using adjusted p-values using the Bonferroni method [34] and level of significance $p<.05$ are reported here. Data were analysed using IBM SPSS 26 [35].

B. Participants

The final sample of STEM professionals contained 217 valid responses (107 F, 105 M, 5 non-binary / unknown). There was geographical representation from across the UK (except Wales and Northern Ireland), but with a majority (52%) of the sample from the North East of England. The majority of the survey respondents were over 35 years old (under 24: 4%; 25-34: 19%; 35-64: 74%; 65+: 3%), and held a higher degree (GCSE: 4%; A-level or equivalent: 5%; Batchelors degree: 29%; Masters or doctorate, 59%; other 3%). The participants in the sample were older [35] and more highly qualified [36] than the equivalent working age population in the North East of England.

Participant job titles were classified according to the Standard Occupational Classification (SOC) for the UK [37] as shown in Table 1, with all jobs falling into the first three categories of the classification confirming that the survey was completed by a mainly professional audience. SOC2 is broken down further into the minor occupational classification and showed that the majority of respondents were from natural and social science backgrounds (Table 1). The SOC 3 category (Associate professional occupations) was formed predominantly from participants who gave their job title as school science technician (n=47) making them 22% of the total sample. This is a support role within the English education system which involves organising equipment and consumables used within science lessons, supporting teachers with practical work and ensuring that health and safety regulations are followed in the science department.

TABLE I. PARTICIPANTS' OCCUPATION ACCORDING TO MAJOR SOC GROUPINGS, WITH A DETAILED BREAKDOWN OF OCCUPATION TYPES FOR THE SOC2 CATEGORY

SOC		*N*	*% M*	*% F*	*% non-binary /unknown*
1	Managers and senior officials	11	36	64	0
2	Professional occupations (all)	144	47	51	2
	211 Natural and social science professionals	*75*	*47*	*52*	*1*
	212 Engineering professionals	*19*	*79*	*21*	*0*
	213 IT and telecommunication professionals	*17*	*60*	*29*	*1*
	231 Teaching and education professionals	*19*	*74*	*23*	*0*
3	Associate professional occupations including technicians	59	59	37	3

IV. Results

A. Self-identified attributes

Some participants gave fewer than the possible six terms to describe their attributes, leading to a total of 1180 terms given by the respondents. Initial grouping of very similar terms gave 269 unique terms for attributes. The 15 most commonly named terms after this initial grouping account for 57% of all the named attributes (Table 2). Terms related to intelligence or high academic ability were given only by 3 participants, and do not appear in the table. Individual terms were also classified as 'hard' (41%) or 'soft' (59%) skills following the classification described by [17].

Iterative thematic analysis of the 269 unique terms yielded 19 themes (Table 3) including the 16 NUSTEM attributes, containing varying numbers of the unique terms. In addition to the 16 NUSTEM attributes a further 3 broad themes emerged (Domain specific knowledge, Good colleague, and Professionalism). A small number of terms (e.g. deceitful, physically fit) could not be categorised in the main emergent themes and were placed in an 'other' category. They were not included in the further data analysis. Some themes contained a greater number and variety of words than others and were used by differing numbers of respondents as can be seen from Table 3. The majority of themes contained terms which were identified exclusively as soft skills or hard skills, but two themes (professionalism and imaginative) contained terms relating to both hard and soft skills.

TABLE II. THE 15 MOST COMMONLY GIVEN ATTRIBUTE TERMS

Term	*frequency*	*% n=1180*	*hard / soft skill [17]*
Communicator	93	8	soft
Collaborative	62	5	soft
Organised	50	4	hard
Curious	44	4	soft
Problem solver	42	4	hard
Subject knowledge related terms	39	3	hard
Creative	38	3	soft
Analytical	29	2	hard
Flexible	28	2	soft
Patient	27	2	soft
Logical	25	2	hard
Adaptable	24	2	soft
Time management	24	2	hard
Methodical	21	2	hard
Resilient	20	2	soft

TABLE III. THE 19 ATTRIBUTE THEMES SHOWING TYPICAL TERMS, THE PERCENTAGE OF PARTICIPANTS WHO USED A TERM CONTAINED WITHIN THE THEME, THE NUMBER OF TERMS IN EACH THEME, AND WHETHER THE TERMS WERE CODED AS HARD OR SOFT SKILLS.

Attribute Theme	**Typical responses**	**% participants with this attribute (n=217)**	**No. terms contained in the theme (n=1172)**	**hard / soft skills [17]**
Open-minded	Adaptable, embraces change, growth mindset, healthy level of scepticism	48%	44	soft
Communicator	Teaching skills, diplomacy, good writer, delivering clear presentations	46%	113	soft
Logical	Critical thinker, accurate, analytical, able to improve processes	40%	114	hard
Domain specific knowledge	Numerate, data fluency, industry/subject knowledge, safety conscious	37%	117	hard
Curious	Asking questions of everything, interest in learning, like to try out new things	35%	85	soft
Creative	Innovative, inventive, resourceful, experimental	33%	77	soft
Good Colleague	Fair, friendly, interpersonal skills, humour, generous, helpful, honest, reliable	33%	89	soft
Resilient	Don't give up, learn from mistakes, problem solver, unflappable	32%	70	soft
Collaborative	Team player, learn with and from others, supportive	30%	72	soft
Tenacious	Persistent, perseveres, determination, focussed, diligent	22%	54	soft
Hard-working	Determination, energetic, disciplined, thorough	20%	47	soft
Self-motivated	Ambitious, can-do attitude, independent learner, positive attitude	18%	44	soft
Professionalism	Accountability, integrity, leadership, vision,	15%	40	both
Patient	Patient	13%	27	soft
Observant	Attention to detail	12%	24	hard
Passionate	Enthusiasm (about subject), love for STEM, passion	12%	30	soft
Organised	Ability to multitask, good time keeping, meticulous	9%	96	hard
Imaginative	Lateral thinking, making connections between subjects	8%	21	both
Committed	Dedicated, output driven	4%	8	soft

B. *Demographic variation of self-identified attributes*

As indicated previously 47 participants (22%; 29 female, 16 male) gave their job title as school science technician (SST). Table 4 shows the top four attributes for each group and by gender.

Associations between demographic characteristics and the attributes were analysed for three groups: all participants, SST, and other professionals. In the majority of cases the null hypothesis was accepted and no significant association was found between demographic characteristics and an attribute. However, a small number of significant associations were identified. For brevity, only the associations with a level of significance p<.05 are reported here.

There was a weak positive association (ϕ=0.203, p=.004, n=75) between gender and 'Domain specific knowledge' with male participants more likely to use words related to domain specific knowledge than female participants.

There was a weak negative association (ϕ=-0.259, p<.001, n=73) between job role (SST / other professionals) and the attribute 'Curious' with other professionals more likely to use words related to curiosity, and a weak positive association (ϕ=-0.338, p<.001, n=18) between job role and the attribute 'Organised' with SST more likely to use terms related to organised than other professionals.

There was a weak association (ϕ=0.319, p<.001, n=215) between age and the attribute 'Domain specific knowledge', and visual inspection of the data indicates that more participants in the age groups 45-54 and 55-64 were likely to use that term.

There was a weak association (ϕ=0.232, p=.047, n=215) between age and the attribute 'Organised', and visual inspection of the data indicates that more participants in the age group 25-34 were likely to use that term.

There were weak associations between qualification level and the attributes 'Curious' (ϕ=0.281, p=.003, n=215), 'Professionalism' (ϕ=0.241, p=.029, n=215), and 'Tenacious' (ϕ=0.3, p=.002, n=215). Visual inspection of the data indicated that in each case participants with a doctorate were more likely to use these terms than participants with other maximum level of qualifications.

TABLE IV. MOST COMMONLY IDENTIFIED ATTRIBUTE THEMES FOR ALL PARTICIPANTS, SPLIT BY GENDER AND ROLE (SCHOOL SCIENCE TECHNICIAN AND OTHER PROFESSIONALS).FIGURES IN BRACKETS INDICATE THE PERCENTAGE OF EACH GROUP WITH THAT ATTRIBUTE

All participants (n=215)	**female (n=107)**	**male (n=103)**		**School science technician (n=47)**	**Other professional (n=173)**		**female other professionals (n=78)**	**male other professionals (n=87)**
Open-minded (48%)	Open-minded (55%)	Communicator (50%)		Tenacious (85%)	Communicator (47%)		Open-minded (54%)	Communicator (51%)
Communicator (46%)	Communicator (44%)	Domain specific knowledge (46%)		Open-minded (55%)	Open-minded (45%)		Communicator (49%)	Domain specific knowledge (43%)
Logical (40%)	Logical (42%)	Open minded (41%)		Domain specific knowledge (49%)	Curious (40%)		Curious (49%)	Open-minded (39%)
Domain specific knowledge (37%)	Curious (39%)	Logical (38%)		Logical (43%)	Logical (40%)		Logical (42%)	Logical (37%)

C. Utility of the 16 STEM Attributes

Participants were presented with the 16 STEM Attributes and asked "How much do you feel that these attributes describe you as a STEM professional?". The median response for every attribute was 5 (Strongly agree). For analysis the five Likert ratings were collapsed into new variables to represent 'agree', 'neither', or 'disagree' and fig.1 shows the percentage of responses. The attribute with the highest overall positive response was 'Logical' (93.5%) and the attribute with the lowest overall cumulative positive response was 'Patient' (74%). The attribute with the highest overall negative response was 'Organised' (7.9%) and the attribute with the lowest overall negative response was 'Open-minded'(2.3%).

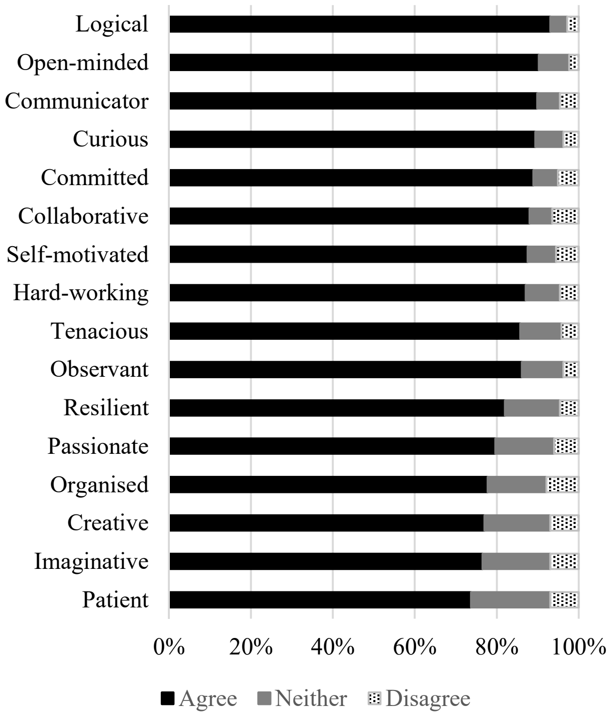

Fig. 1. STEM professionals ratings of how well each of the 16 STEM Attributes are representative of them.

V. DISCUSSION

The first research question explored in this study was 'How do STEM professionals describe the attributes that they have which make them successful in their role?'. Our findings identified a broad range of attributes with 269 unique terms being identified by participants. However, there was a degree of commonality amongst responses with the 15 most often named terms containing 57% of the terms used.

Some of the 19 themes identified emerged directly from the most commonly given responses as can be seen by the level of overlap between the terms in Table 2 and attribute themes in Table 3. Following the classification used in [17] the attributes can be considered to represent hard skills (domain specific knowledge, logical, observant, and organised) and soft skills (open-minded, communicator, curious, creative, good colleague, resilient, collaborative, tenacious, hard-working, self-motivated, patient, passionate, committed) with some themes containing terms relating to both soft and hard skills (professionalism, imaginative).

The 19 themes identified are congruent with previously identified skills sets [16] and competencies [17]. For example, 'collaborative' fits within 'relationship management skills' [16] or 'teamwork and cooperation [17] and 'logical' sits within 'cognitive and problem solving skills' [16] or 'Analytical thinking [17].

Notably, terms related to hard skills represent only 32% of the total terms, while soft skills represent 68% of the total terms used by the participants of this study. The three themes containing the most terms were 'domain specific knowledge' (n=117, 10%), 'logical' (n=114, 10%) and 'communicator' (n=113, 10%) and terms relating to these three themes were given by 37%, 40% and 46% of participants respectively (Table 4). The difference arises because some participants gave two or more terms related to a single attribute theme.

Whilst it might be expected that hard skills such as 'domain specific knowledge' and 'logical' would be felt to be important by STEM professionals, the responses show that overall soft skills made up a far greater proportion of the responses given, both in the number of terms given and the number of participants using those terms. This finding indicates that, in common with employers [9], and job adverts [23][22], professionals in STEM fields consider soft skills to be integral to their roles.

Looking in more detail at the responses coded as 'domain specific knowledge' participants included terms such as 'numerate' and 'IT literate' alongside knowledge of technical information and sector practices. For example, a participant who gave their job as Development engineer reported that they needed an 'understanding of mechanics' and 'understanding of manufacturing processed (sic)', and a participant working in the agricultural engineering sector reported that they needed 'engineering knowledge' and 'industry knowledge'. Interestingly, terms related specifically to very high intelligence or academic ability were rarely used by the STEM professionals appearing in only 8 responses. This is in direct contrast to the common stereotypes of STEM professionals, particularly scientists, which are that they are, or need to be, very intelligent [39][31]. One possible explanation for this finding is that the social work environment of STEM professionals includes peers that they consider to have a similar level of intelligence as themselves, and therefore it is not identified as an attribute that makes a STEM professional successful. Further study is required to fully understand the reasons for this finding.

Nonetheless, common stereotypes of STEM professionals as highly intelligent can be counter-productive and cause young people to choose not to study STEM subjects because they see them as being for people who are much cleverer than them [40]. The finding from this study that STEM professionals (including engineers) do not report a high level of intelligence as a key attribute could be used to help counter such stereotypes and negative consequences. It also supports the initial decision made by the outreach team not to include the attribute 'clever' in their 16 STEM attributes, and to encourage teachers to avoid describing scientists as 'very clever' or 'very intelligent'.

There is overlap between the attributes identified in this study and skills that employers say they are looking for [12]. This could be, in part, because the participants in the study were those who are already STEM professionals and have been successful in their chosen field, leading to a 'selection bias' in the skills that they value. However, the breadth and commonality of skills identified by employers and employees, particularly when they don't involve specific technical knowledge or skills [16][2] suggests that the attributes identified would be similar for an equivalent group of non-STEM professionals, see e.g.[6].

The second research question was 'Do the attributes of STEM professionals vary depending on educational background, gender and age?'. The analysis of association between demographic factors and each attribute shows that for the majority of attributes there was no association between attribute and educational background, gender and age, indicating that in most cases the attributes do not vary according to demographic characteristics. Where there was an association, then the level of association, whilst significant, was weak.

Previous research has suggested that hard and soft skills can be constructed as being gendered [41][19], that male engineering students may undervalue training in communication and other soft skills [42], and that female engineering students may feel typecast by the perception that soft skills are due to an innate (feminine) ability [43]. The current study did find a weak association between gender and the use of domain specific knowledge terms (coded as 'hard' or 'technical' skills), with male respondents tending to use more terms in the domain specific knowledge theme, as can be seen in Table 4. However, that was the only theme where there was an association between gender and an attribute, indicating that all participants valued the other attributes equally, regardless of whether they were coded as soft or hard skills.

The proportion of school science technicians in the sample allowed exploration of the association between that role and the attributes, and found that schools science technicians were slightly more likely to identify as 'organised', and slightly less likely to identify as 'curious' than other professionals. These associations hint at the logistical, organisational and support role of school science technicians [44].

The third research question was "Do the STEM professionals' attributes correlate with the NUSTEM attributes?" and looked at the overlap between the self-identified terms and the 16 STEM attributes used by the outreach group. The data show that there is an overlap. Of the fifteen most commonly named terms (Table 3), eight are found in the STEM attribute list: communicator, collaborative, organised, curious, creative, patient, logical, resilient.

Following thematic analysis, in addition to the 16 STEM attributes, a further three themes also emerged: good colleague, professionalism and domain specific knowledge (Table 4). Terms categorised as 'good colleague' could be seen as personal behaviours that many schools promote within behaviour policies and practices, such as 'kind', 'reliable', and 'honest'. Terms categorised within 'professionalism' included 'accountability', 'integrity', and 'vision' which again could be considered personal qualities and behaviours.

Looking at these three additional themes, the question arises as to whether they should also be included in the list of STEM attributes used by the outreach group. Domain specific knowledge is not included explicitly in the attribute list, however, many of the interventions and resources developed by the outreach group do address specific curriculum topics or provide the opportunity to develop practical or numerical skills, and with older students, highlight the different qualification routes to STEM careers. Thus, indirectly this theme is included in the work of the outreach group. However, the other two themes (good colleague and professionalism) included a range of behaviours and personal attitudes. To be useful in a teaching and outreach context, these themes would need to be broken down into a wide range of individual actions (e.g. be kind, be honest, have integrity) and so have less direct utility when discussing broad attributes for the workplace with students. Some of the terms used (e.g. sense of humour, leadership and selfless) are not amenable to easy development in a short-term school intervention, reducing their utility for the outreach group. However, given their appearance in the data, the outreach group will give further consideration to the narratives used within interventions to highlight that these attributes are also important to STEM professionals.

During thematic analysis terms linked to two attributes included in the STEM attribute list, tenacious (working to achieve a goal even if it is difficult) and resilient ('able to be happy, successful, etc. again after something difficult or bad has happened') , proved to be the most challenging to categorise. The outreach group spent some time discussing the most appropriate placement of each term because many of the terms given by participants could justifiably be placed in either theme, as both refer to keeping going or bouncing back through difficulties. Consequently, it was felt that, where either term could be used, in future workshops and resources 'resilient' would be used, as this was a concept that was popular in school discourse.

When participants were asked how much the 16 STEM attributes describe them as a STEM professional, almost everyone said that all 16 STEM attributes described them well. This indicates that the chosen attributes are a good set to describe the STEM workforce. The highly positive response to all of the attributes is also similar to previous findings that employees and employers think that a broad range of soft skills are important [8][12].

One important question to ask when planning STEM engagement activities is whether using attributes is limiting young people's future careers by focussing on skills in STEM? As seen, the attributes identified in this study are congruent with the attributes that employers in a range of STEM and non-STEM fields say that they are looking for in their employees [16][17][7] including interpersonal and collaborative skills, cognitive and problem solving skills, productive self-management and creative and innovative skills [16]. Furthermore, an analysis of online job vacancies found many apparently non-STEM jobs require STEM knowledge and skills and vice versa [6]. Thus, focussing on shared attributes provides an insight of employability skills for young people which they can take into whichever career direction they choose.

VI. Limitations

The self-selecting nature of the participants in the study means that they are not representative of the UK STEM profession overall. For example, [45] found that 12% of people in engineering professions were female, but the percentage of women in our survey was 21%. Similarly, our sample was skewed to the North East of England, and to an older, more highly qualified demographic when compared to the NE and UK labour market [36][37]. However, the skills identified by the participants in the study are congruent with those identified in other studies of employers [7][16] and students [46], indicating that this limitation has not affected the overall utility of the study.

VII. Conclusion

This study has shown that engineers and other STEM professionals think that a range of soft skills have helped them to be successful in their careers, in addition to technical (hard) skills. The research indicates that there is merit in looking beyond subject knowledge to frame engineering education and engagement activities, and that soft skills have utility and value for current and future STEM employees. The 16 STEM attributes used by the outreach group realistically represent the attributes of those already working in STEM, and their use in outreach activities could help children and young people to identify the skills that they already have (or could develop). This would also support students with employability by enabling them to elucidate the value of their own skills to a future employer, in whatever sector they enter.

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