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# UK AND USA UNIVERSITY OUTREACH PRACTICES: THE NEED TO DEVELOP STEM LEARNING PEDAGOGIES FOR STUDENT AMBASSADOR ACTIVITY

ABSTRACT

*In the United States, the United Kingdom and other developed countries university outreach initiatives have been developed to promote progression in STEM subjects and increase uptake of STEM among women, poorer students and minority groups who are currently severely underrepresented on many post compulsory and undergraduate STEM courses. Research indicates that young people often dis-identify with STEM subjects and careers at an early age and highlights the importance of adult figures in motivating young people's engagement. During the past two decades in the United Kingdom and the United States, university students have been widely used by universities to support STEM outreach work with younger students. These student ambassadors are generally assumed to act as positive role models for school students because of their proximity in age and life stage, and are widely seen as able to contribute to valuable STEM learning opportunities and to support progression in these subject areas.*

*This chapter draws on findings from two research studies, in the UK and US, exploring student ambassador STEM outreach activity with school age students, including the settings and content of activities and how ambassadors are matched with younger students. The studies reveal the potential of ambassadors to challenge younger students' self-identities in relation to STEM, but also identify problems of organising and funding outreach to effectively engage large numbers of young people from underrepresented groups.*

*In the UK, university outreach activity is often located in administration and marketing departments with limited involvement of academic faculties, which can mean that the pedagogical aspect of activities are overlooked. In the US, while recruitment is still a focus, funding incentives and an emphasis on public*

*engagement have led to increased engagement of academics and consideration of learning and teaching in outreach activity at some institutions. This chapter points to the need for a sharper focus on pedagogy, particularly in UK contexts, and an increased focus in both countries on outreach practice that effectively supports identification between student ambassadors and younger students whilst reaching wider audiences of young people. The chapter highlights the need for increased collaboration across universities to identify and support best practice and promote effective and far reaching student ambassador STEM outreach activity.*

*Key words: STEM, equity, university outreach, widening participation, student ambassadors, informal learning*

## INTRODUCTION

Across developed countries over the last two decades there has been a wave of widening participation policy initiatives aiming to increase and widen participation in HE. Driving this policy agenda has been the increasing economic need for high level skills and concerns over addressing skills shortages in STEM. The UK and US are presented with similar challenges, with relatively low numbers of students progressing onto STEM post-compulsory courses, particularly in the physical sciences (Eilam, Bigger, Sadler& Bielik, 2016; Royal Society, 2010). In both countries lower socio-economic groups, girls and black and minority ethnic young people are under-represented in post compulsory STEM study and in STEM careers (Baker, Krouse, Yasar, Roberts & Robinson-Kurpius, 2007; Eilam, Bigger, Sadler& Bielik, 2016; George, Castro & Rincon, 2018; Morley, 2012; Smith and White, 2011;).

University outreach activity in the US has a long history and academic faculties are widely engaged (Younger, Gascoine, Menzies & Torgerson, 2018). In comparison, in UK outreach activity there is generally more limited engagement by academic staff (Watermeyer, 2015). HE outreach has three broad areas of focus: raising aspirations by promoting the benefits of university study, promoting attainment and fostering civic engagement (Gartland & Hayton, 2020). The focus on aspiration raising, dominant in most UK university outreach activity has been widely critiqued for problematizing individual students and ignoring structural obstacles facing underrepresented young people (Burke 2012; Bridges, 2005; Harrison, & Waller, 2017).

In the US and UK university student employees and volunteers support outreach work. These students have a range of titles, with ambassador being one of the most common (Gartland, 2014). In both countries student ambassadors often support STEM intervention programmes focused on promoting progression and recruitment of under-represented groups in STEM subjects. Ambassadors widely support general promotional activity and public science engagement activity. At some universities in the US, STEM student ambassadors live together on university campuses in villages (e.g. STEM Women or engineering) (Gartland, 2020) and in some instances form an elite group of students who represent institutions. In both countries ambassadors are extensively used in recruitment activity but in the UK where outreach activity is often organised by widening participation practitioners

located within marketing and recruitment departments, this focus can be especially dominant.

Student ambassadors are widely assumed to make ideal role models that younger students will aspire to (Gartland, 2014). Research points to the importance of pupils' 'self-identity' in STEM and indicates young people and particularly girls, decide careers in STEM are not viable for them at an early age (Archer, DeWitt, Osborne, Dillon, Willis & Wong, 2010; Macdonald, 2014). The importance of adults in motivating and encouraging students to progress in STEM, contributing to students forming STEM identities, has been widely acknowledged (Macdonald, 2014; Miel, Portsmore, Maltese & Paul, 2018; Rodd, Reiss & Mujtba, 2013) and lack of positive role models continues to be an issue, especially for girls who often see STEM careers in stereotypical ways and as male domains (Cheryan, Vichayapai, Drury & Kim, 2011; Macdonald, 2014). Dasgupta (2011) suggests subtle indicators in different environments signal who belongs, and points to the importance of the presence of similar peers to inoculate against stereotypes, particularly for people from disadvantaged groups. Various studies have focused on how young people make university choices and identify the importance of informal relationships in providing information viewed as credible by young people (Archer et al., 2003; Brooks, 2003; Reay et al., 2005). This research highlights the potential student ambassadors have in enabling younger students to identify with STEM as well as being viewed as credible sources of information about STEM courses. Campus visits where school students meet university students and lecturers have been found to have an important impact on young people's decisions about university (Slack, Mangan, Hughes & Davies, 2012). Slack et al. (2012) found that 'previously unknown university students' who younger students only met once during university open days became important sources of information about institutions and courses. This suggests school students' can quickly come to view student ambassadors as aspirational figures, who they see as people like themselves (Archer at al. 2003; DeWitt, Archer, & Osborne, 2013).

However, it is important to challenge widespread assumptions that young adults working with school students are automatically viewed as role models who promote positive views of university (Gartland, 2014, 2015). There is little understanding of how these processes work; of the impact of different learning contexts within which ambassadors are placed, or the importance of matching aspects of ambassadors and school students' identities (Gartland, 2014, 2015; Sanders & Higham, 2012). The significance of intersecting identities (Crenshaw, 1989) including gender, ethnicity and class has been widely discussed in the context of mentoring relationships. Liang and Grossman, also point to the significance of 'shared interests' (Liang & Grossman 2007, p. 251). Shared interests and intersecting identities have both been found to be relevant to student ambassadors' relationships with young people but there is a need to better understand this and how different outreach practices affect these relationships (Gartland, 2014, 2015).

The significance of the location of outreach activity has been highlighted, especially campus visits (Taylor, 2008; *Qualitative Evaluation of the Aimhigher Associates Programme*, 2010; Slack et al, 2012; Hatt et al, 2009; Gartland 2014, 2015, 2016). As Slack et al.'s (2012) study reveals, student ambassadors encountered by school students during university visits are often viewed as reliable

sources of information. Hatt, Baxter and Tate (2009) point to the value of summer schools held on campus. These findings indicate that outreach activity physically located at universities is valuable in engaging and motivating school students. The pedagogies of outreach activity are also significant. In higher education in both the US and UK, there have been significant moves towards experiential, active problem or project based learning in STEM subject areas. These pedagogical approaches are generally viewed as more effective in engaging women and diverse students (Arlett, Lamb, Dales, Willis & Hurdle, 2010; Boursicot & Roberts, 2009). Where there is wider engagement of academics, there is an increasing body of research into STEM outreach activity, notably from the US, and the benefits of experiential and active approaches, including problem based learning and design based science have been highlighted (Evans, Lopez, Maddox, Drape & Duke, 2014; Schnittka, Brandt, Jones & Evans 2012; Schnittka, Evans, Won & Drape, 2015). However, despite the widespread practice of using ambassadors in this activity, there is little research that focuses specifically on the contribution they make (Gartland, 2014; Miel et al, 2018).

Theories from work-based learning, including about 'formal' and 'informal' learning (Beckett and Hager 2002; Colley, Hodkinson, and Malcolm 2003) are relevant when thinking about the location of outreach activity, pedagogical practices and how these affect ambassadors' interactions with school students. Colley et al. (2003) suggest that experiential pedagogic approaches are 'attributes' of informality in learning situations; these attributes of formality/ informality have been found to contribute to school students effectively identifying with student ambassadors (Gartland, 2014, 2015). Poststructuralist thinking about identity is also relevant when considering the interactions between ambassadors and school students (ibid.). Poststructuralists present an understanding of individual subjectivity as created through available discourses and ways of being embedded within particular cultures and moments in history. Butler (1990, 1997a) suggests identity is 'performed' and we become who we are through the ways we speak and behave - that our identity is 'constituted through action' (David, Coffey, Connolly, Nayak & Reay, 2006). In their study of science identities, Archer et al. (2010, p.2) point to the need for more research that 'understands learning as tied to processes of identity construction' and explain that primary school children's level of interest and engagement with science is 'shaped by their social structural locations', and that there are classed, racialized and masculine/ feminine identities that that young people 'see as desirable and constitutive of the self' (2010, p.3). They suggest that science identities are seen as counter to these desirable gendered identities:

> Its [science's] boffin associations and incongruence with popular/desirable forms of contemporary masculinity and femininity (especially working-class configurations) make it a potentially risky identity being closely associated with markers of an "uncool" identity. (2010, p.18)

Understanding STEM learning as intimately linked to identity presents a significant challenge in organising outreach activity if the ambition is to engage more girls and diverse groups. However, this understanding of how STEM identities are shaped also presents opportunities; as Burke (2012) points out, 'aspirations are relational… formed in relation to others' (2012, p.109). If ambassadors can be positioned as aspirational role models during outreach activity, they could contribute to challenging young people's ideas about desirable identities

in relation to STEM subjects and careers (Gartland, 2014, 2015; Miel et al., 2018). Recent research using the lens of 'possible selves' from social psychology (Markus and Nurius, 1986) could provide additional ideas about how to challenge STEM identities and existing patterns of engagement with these subjects and careers. The theorisation of 'possible selves' provides tools for considering how young peoples' developing future conceptions, can positively shape and influence their behaviour in the present, acting as 'cognitive bridges between the present and the future' (Markus and Nurius, 1986, p. 961). The importance of active experiential learning in facilitating the development of well elaborated possible selves has been noted (Gartland & Smith, 2018; Harrison, 2018; Ibarra, 2007). In his proposed conceptual model for access to university, Harrison highlights the importance of early interventions with school students to 'expand the pool of possible selves available' and, at later points in their school lives to provide opportunities for them to elaborate 'vivid and detailed' like to be future possible selves (Harrison, 2018, p.12-13).

There are, however, concerns about the extent to which university outreach activity is effectively reaching diverse young people. In both the US and UK competition between universities for qualified students is often high and a focus of outreach activity on qualified young people is leading to concern that university outreach with underrepresented groups is simply redistributing students already interested in HE and in studying STEM between universities, rather than reaching new groups of young people (Sadler, Eilam, Bigger & Barry, 2018; Younger, Gascoine, Menzies & Torgerson, 2018). A further issue is that young people can dismiss futures in STEM very early in their school careers (Archer, DeWitt, Osborne, Dillon, Willis & Wong, 2010; Macdonald, 2014). This presents a challenge to universities, especially in the UK where there is an increasing 'blurring of the lines between access activity and recruitment activity' (Harrison and Waller, 2017, p.157), as students at primary and early secondary/middle school are not the natural target groups for outreach aiming to recruit to university courses. These issues raise questions about how outreach work can be organised differently to include younger, more diverse and wider audiences of young people.

This chapter draws on studies of student ambassador STEM outreach activities in London in the UK, and Boston and North Carolina in the US. The chapter considers ambassadors' interactions with school students and how interactions can encourage younger students to identify with them, promoting the development of STEM identities. The challenges in both countries posed by funding constraints and a focus on recruitment, balanced against the urgent need to reach wider audiences of diverse students are considered. The chapter concludes that there is a need for more academic faculty engagement in outreach activity and focus on subject specific approaches in outreach, particularly in the UK and for a sharper pedagogical focus in the planning of ambassador outreach activity in both countries.

## THE STUDIES

The studies were undertaken in six different universities in the UK and US. The research in the UK was conducted over a two-year period at two London universities, one new and one elite. In this study I focused on student ambassadors' outreach work in engineering, medicine and related STEM subjects. Two

externally funded programmes, focused on outreach activity to widen HE participation in engineering and medicine, were considered. Additionally, I considered STEM outreach activity funded by the universities themselves through allocated funding for widening participation activity. Activities predominantly targeted secondary/high school students between the ages of fourteen and seventeen. Activities included summer schools in engineering and medicine, one day visits to universities/ the workplace to engage in practical engineering/ medicine related activities and some work in schools e.g. maths workshops. Activities in medicine targeted high achieving students whilst students largely self-selected to attend engineering programme events.

The US study was undertaken over four weeks but included a wider range of institutions and programmes. I elected to visit the US as outreach has a much longer history than in the UK and there is more grant funded and public engagement activity in STEM. The four universities I visited were identified based on published research about K-12 STEM outreach activity. These universities were located in Boston and North Carolina: two were state universities and two private. Thirteen different outreach programmes in a range of STEM subjects were considered, including programmes in sciences, medicine and engineering. These programmes targeted a wide age range of students including from elementary and middle schools as well as high schools. Activities included similar activities to those found in the two London Universities, such as a university summer schools and day events at universities as well as a range of activities held in schools. Several programmes were long term with school students visiting universities on several occasions (over a period of months or even years). Students were selected for some programmes based on their existing levels of achievement and engagement with STEM while other programmes worked in schools inclusively with whole class groups.

Researching student ambassadors' work with school pupils is challenging as encounters are often extremely brief. Participant observation has been an important strategy, allowing me to observe a wide range of ambassador/school student interactions in both countries. In both countries I interviewed and held focus groups with ambassadors and project organisers and in the US I interviewed academics involved in outreach activity. For the UK study I also held focus groups with school students. I developed a loosely structured schedule for interview/focus group conversations to enable participants to freely relay their understanding, knowledge and experiences (Kvale 1996; Charmaz, 2014). Questions drew on narrative approaches (Hollway & Jefferson, 2013) to encourage participants to identify areas of focus important to them during their accounts of experiences. Interviews and focus groups were recorded and transcribed where possible or detailed notes were taken.

An inductive approach was developed to analyse the data. Notes and interview/ focus group transcripts were analysed drawing on a constructivist grounded framework (Charmaz, 2014), including line-by-line coding of all data and developing in-vivo codes using participants' language. This ensured that I started 'from the words and actions of respondents' (Charmaz, 2014, p.121). By comparing different organisers' and ambassadors' accounts of activity and my own field notes I was able to develop insights into issues and approaches across programmes. In the UK study, I additionally drew on Foucauldian discourse analysis (Willig, 2001) considering dominant discourses across different

programmes and learning contexts. Findings from this discourse analysis framed my research questions for the US study.

Foci included how ambassadors engage with school students and how they can most effectively promote STEM identities amongst young people currently under-represented in these subjects. Connected to this was the importance or otherwise of matching backgrounds of ambassadors and school students and which aspects (e.g. gender, ethnicity, class, subject interests) of young people's identities it is important to match. Additional questions included how ambassador schemes are organised and funded and which young people are targeted by outreach activity.

## MARKETING VS PEDAGOGY

In both countries, accounts of the work of ambassadors drew heavily on neoliberal discourses of the marketplace. Ambassadors were positioned as marketers and school pupils and their parents as potential consumers. Accounts of academics, ambassadors and school pupils were infused with references to their positioning as consumers or marketing institutions and courses:

> It's an 'arms race' to attract customers, and customers want to talk to other customers – they want to talk about students and find out about the student experience… student ambassadors are an important aspect of our marketing strategy for high end students – the high achiever kids (Academic: North Carolina,US)

At the two London universities, the widening participation units responsible for organising and overseeing outreach activity, were located within recruitment and marketing departments. This led to these foci becoming intertwined and inextricably linked across activities (Gartland, 2013, 2014). The engineering programme, running in one London university at the time of the study, contributed to a specific focus on engineering in some outreach activity. One project worker on this programme described how ambassadors were told to 'promote engineering messages, challenge the stereotype of engineer as mechanic and make university seem accessible' and ambassadors widely discussed promoting engineering messages and challenging stereotypes. While these foci were different to those of the general widening participation units of the universities, the emphasis during all activity was on promoting engagement and raising aspiration. There was little academic faculty engagement in outreach activities observed. The location, organisation and funding of outreach in many UK universities has meant that academic faculty engagement has been very limited (Watermeyer, 2015) (though the introduction of access and participation plans[1] in 2020-21 may change this).

In comparison, in the US there was more discussion of pedagogy which seemed to be largely due to the interest and engagement of academic faculty. This faculty engagement appeared to be motivated by both a sense of civic duty and funding incentives. This pedagogic focus was particularly evident in engineering outreach activity. In the US, there has been a national discussion about learning and teaching approaches following the drive to introduce engineering into the K-12 curriculum (Katehi, Pearson & Feder, 2009), with three principles identified to provide a clear vision of what K-12 engineering education might look like. These three principles are that engineering education should: emphasize engineering design, incorporate important and developmentally appropriate mathematics, science and technology knowledge and skills, and promote engineering 'habits of mind', which include

systems thinking, creativity, optimism, collaboration, communication and ethical considerations. These principles were widely discussed by engineering academics in relation to outreach activity and directly informed planning. Engineering academics in some instances, worked closely with ex-school teachers also based within universities to plan outreach activity. One academic explained that the focus of outreach is 'to characterize the true nature of engineering and develop engineering habits of mind'. Several science and engineering academics identified the importance of 'disciplinary fidelity' and that outreach activity should mirror experiences of subjects in higher education: 'it's important for young people to understand what engineering looks like at university'. One academic described how student ambassadors were expected to develop activity within a prescribed framework drawing on pedagogies informed by the National Academy of Engineering and engineering education department at the university. Sessions ambassadors led had to be organised into timed sections: ten minute presentations, five to ten minute planning session, thirty minutes of building time and ten minutes sharing. The ambition of this outreach activity was to develop younger students' self-efficacy and challenge them to work collaboratively to find solutions to problems. Ambassadors and academics on several programmes discussed the importance of 'allowing young people to fail' and encouraging them to develop resilience, seen as vital for undergraduate study. Engineering ambassadors at universities I visited in the US in both North Carolina and Boston were part of a wider national community, the 'Engineering Ambassadors Network' (EAN)[ii]. EAN holds regular workshops funded by the National Science Foundation (NSF) to support ambassadors' outreach activity. These ambassadors were part of a wider national conversation about outreach activity in engineering. EAN provide guidelines for ambassadors about structuring presentations, using the Assertion Evidence Method where slides are used to provide memorable evidence to support key points, often through visual images.

The pedagogical focus found amongst ambassadors, academics and organisers (often ex-school teachers) in some US universities contributed to reflection about best practice in outreach activity within disciplinary areas and provoked some innovative and thoughtful approaches, including a range of experiential learning strategies. Where activity is organised without the interest and engagement of subject specialists from academic faculties, as in many UK universities, these conversations cannot so easily take place. However, though there was a focus on pedagogy within individual subject areas in some US universities, there appeared to be little dialogue between STEM disciplines about outreach activity.

## 'THEY ARE BASICALLY LIKE US': AMBASSADOR INTERACTIONS

### *The importance of learning contexts*

The learning contexts within which activity in both countries took place varied widely including by pedagogical approach, location and duration as well in numbers and groups of younger students targeted. Different learning contexts must be carefully interrogated if strategies area to be developed that effectively engage more underrepresented young people with STEM. The setting and focus of outreach activity and pedagogical practices all position student ambassadors in particular ways, either supporting young peoples' identification with them or

contributing to a sense of difference (Gartland, 2014, 2015). If student ambassadors are to be effective role models, the extent to which younger students relate to them during interactions is significant. Becoming a role model is not an automatic process and there is a need to better understand the practices and pedagogies that encourage young people to view ambassadors as aspirational figures.

Distinctions between different 'learning situations' have been widely theorized in terms of their formality and informality (Beckett & Hager, 2002; Colley et al., 2003), with school based classroom learning widely viewed as 'formal'. Colley et al. (2003, p.30) suggest that in practice, 'elements of both formality and informality' are to be found in every 'learning situation,' and that instead of learning situations being described as formal or informal, formality and informality should be seen as 'attributes' of these situations. Four main groups of in/formal learning attributes are outlined by Colley et al (2003, p.30-31): 'process', 'location and setting', 'purposes', and 'content'. Outreach activities considered in my studies could be placed on a continuum with some activity having many attributes of informal learning and, at the other end of the continuum, other activities having many attributes of formal learning. Findings from both studies indicate that these learning contexts and pedagogies are influential over the relationships that develop between ambassadors and school students.

Findings indicated that learning contexts with more informal attributes, such as those located at universities or in the workplace and where ambassadors worked collaboratively with school students on practical activities, encouraged the development of positive relationships. Many outreach activities had been planned to provide pupils with insights into real-world applications for STEM subjects and drew on practices of experiential project-based learning or the scientific method. This was frequently found in the US where academic faculty staff were directly involved in the development of activity. In both countries, the accounts of organisers and ambassadors indicate that 'hands on' practical activity is important to the development of STEM identities amongst school students. There was a widely held view amongst programme organisers that this practical focus is currently missing in schools, where acquisition (Sfard, 1998) of information for tests drives more traditional teaching approaches.

An example of an outreach programme in the US with a high number of informal attributes was a STEM summer school held at an elite university in Boston for middle school students. An ambassador working on this programme described how she and another ambassador led a series of chemistry sessions. Activities aimed to support young people's understanding of science and focused on using the scientific method. The ambition was to 'push' school students academically, to enthuse them by showing them that 'science and learning can be fun' and to develop 'resilience' by providing young people with a safe learning space where they are allowed to 'fail'. The ambassador described how positively young people responded to her during the summer school, including one girl sending her a card explaining how she had 'inspired her to be a chemist'.

*Table 1. Attributes of 'informality' (Colley et al. 2003): STEM Summer School (Boston, US)*

| | **Process** | **Location and setting** | **Purposes** | **Content** |
|---|---|---|---|---|
| **STEM summer school** | Chemistry sessions led by student ambassadors, not school teachers.<br><br>Focus on hands on activity with no formal assessment. | University Campus | 'No state standard or formal requirements of the programme'.<br><br>No 'predetermined learning objectives', 'curriculum' or 'external certification'.<br><br>Activities aimed to *extend (enhance) school students' knowledge of chemistry* developed at school. | Experiential focus where school students uncover knowledge for themselves. |

Similarly, during a one day long Engineering Event, school students and ambassadors from one university in London worked together to build train platforms and tracks. They were provided with real-world problems relating to this construction process which they had to solve by drawing on their knowledge of science and maths. This included planning the construction of tracks and managing a budget for their construction projects. In this activity, pupils and ambassadors were positioned as learners together, working collaboratively. This learning context had many attributes of informality (Table 2.).

*Table 2. Attributes of 'informality' (Colley et al. 2003): One Day Engineering Event (London, UK)*

| | **Process** | **Location and setting** | **Purposes** | **Content** |
|---|---|---|---|---|
| **Engineering 'Train Tracks' Event** | The learning 'process' was 'negotiated'.<br><br>No planned formal assessment or pressure on ambassadors to ensure particular learning outcomes.<br><br>No 'predetermined learning objectives', 'curriculum' or 'external certification' (Colley et al, 2003, p.30-31). | Company offices | Students had to draw on their STEM subject knowledge, but curriculum learning was not the main aim of the activity.<br><br>'Purposes' were mixed including: *aspiration raising*, developing subject knowledge, promoting key messages about engineering, developing knowledge of progression, routes and careers.<br><br>Outcomes could only be activated by individual learners (Becket and Hager, 2002) as a result of their engagement with activity and ambassadors. Learning outcomes were therefore largely learner determined. | Emphasis was on 'uncovering knowledge derived from experience' |

These two activities shared many similarities in terms of their informal attributes, with both events focused on experiential learning. Unusually for university outreach activity, the Engineering Event was co-planned and supported by engineering employees and so had a sharp focus on the real world application of the science and maths students were learning in school. However, there were differences in terms of the purposes of activities. The learning activities on the STEM summer school were designed to extend students' curriculum learning in chemistry whereas the Engineering Event was focused on aspiration raising and more generally promoting interest in and engagement with engineering.

These events, and other activities where ambassadors worked collaboratively with school students, supporting them in 'uncovering knowledge derived from experience' (Colley et al, 2003: 31), facilitated the development of warm and open relationships. In these learning contexts school students described talking to ambassadors about their own plans and about ambassadors' experiences (Gartland, 2014, 2015). During the Engineering Event (Table 2.), school students discussed being able to relate to ambassadors, seeing them as fellow learners and students but with more expertise or 'skills'. One school student explained how 'knowing someone' with the same interests who is studying at university is motivational - 'drives you more'. Another observed, 'you can talk about your future'. Similarly, during campus events focused on encouraging progression to university in medicine at the elite London university, where ambassadors worked collaboratively with school students using medical equipment and diagnosing medical conditions, younger students described how ambassadors shared with them youthful and learner identities and were 'basically like us', 'role models' - 'they all like to learn and we like to learn'. The subject disciplinary identities of these ambassadors were important to younger students' identification with them, as younger students aspired to study in a similar field. One student during a Summer School in Medicine at the same university explained how ambassadors shared 'very similar ideas' because of this shared interest as 'most of us here want to go into medicine'.

Ambassadors in these and other learning contexts with many 'attributes of informality', described talking with younger students about a wide range of topics. During the STEM summer school at the university in Boston (Table 1.) the ambassador leading sessions described how she talked to younger students about music and TV shows, as well as playing computer games and Frisbee. These social interactions appeared valuable, enabling her to become 'sort of their friend'. Similarly in the London based study, during activities with many attributes of informal learning, younger students frequently described ambassadors as like 'friends', 'cousins', 'brothers' and 'sisters' (Gartland, 2014). The opportunities for social interaction practical learning contexts allowed, contributed to how closely school students identified with ambassadors, even during short events. The social exchanges these learning contexts facilitated enabled ambassadors and younger students to convey their cultural connections, supporting identification (Gartland, 2014, 2015).

*Matching Backgrounds and Performing STEM Identities*

There is a general assumption among outreach workers that matching students to school pupils in terms of gender, ethnicity and class can promote positive outcomes

and there appear to be many different aspects of ambassadors' identities that school students are aware of and respond to. Intersecting (Crenshaw, 1989), including gendered, classed, cultural and raced aspects of ambassadors' identities were highlighted in both UK and US studies. Shared identities were widely viewed by organisers and ambassadors as significant and programmes frequently 'matched' aspects of school students' and ambassadors' identities. For example, at one university in North Carolina, Mexican student ambassadors described the importance of their shared Mexican heritage:

> We approach it through our identities. Other (white) volunteers don't have the same relationship that we do – they can't relate to the students culturally as we can. It's different with us (Ambassador: After School Science club, North Carolina, US)

An ambassador working on an engineering summer school at one London university similarly highlighted the importance of her gender in engaging girls, with some girls being challenged and surprised by her presence:

> Qadira: A lot of the girls say – oh so what engineering do you do? Always, always, always, always – because they always have it in their mind ah that it's just guys. Being a girl there it always seems to get them like interested. … on Monday somebody (girl) asked me – are you meant to be in this room? I was like – yes (Engineering Summer School: London, UK)

These intersecting aspects of school students' and ambassadors' identities, alongside shared interests in particular STEM subjects and disciplines are clearly important and contribute to identification. Ambassadors' accounts of outreach activity in both countries also stressed the importance of enthusiasm during interactions. An ambassador on one programme in North Carolina commented on the need to 'act really excited'. This was echoed by other ambassadors in the US study and even noted in the presentation guidelines shared with Engineering student ambassadors across the country through the Engineering Ambassadors Network (EAN). Ambassadors in studies in the US and UK were consciously *performing identities* (Gartland, 2014, 2016), as enthusiastic STEM students in order to encourage younger students to engage with activity. In learning contexts with many informal attributes, this often appeared successful, with school students joining ambassadors in performing 'STEM university student', especially when activities were located at universities. As discussed previously (Gartland, 2014), these enactments, especially where students shared intersecting gendered, raced, classed identities and subject interests, could be considered as 'performative' according to Butler's theories, with younger students being constituted as future STEM and university students through their participation. This can be conceptualised as a process of 'subjection', the 'making of a subject' (Butler, 1997b, p.83). These shared performances could also usefully be considered through the lens of possible selves. Experiential learning and opportunities for interaction with people who embody possible new identities, have been found to be powerful in supporting the development of vivid, detailed 'like to be' new possible selves (Ibarra, 2007; Gartland & Smith, 2018). However, the UK study indicated that learning contexts with more formal attributes, even when students were 'matched' with ambassadors in terms of gender and ethnicity, were less likely to encourage

the same level of identification and could even promote dis-identification, with schools students clearly articulating ways in which they were unlike ambassadors (Gartland, 2014, 2015).

## THE CHALLENGES OF REACHING WIDER AUDIENCES

### *Working with select groups*

An ambition of several programmes at US universities was to provide young people from underrepresented groups, particularly girls, hispanic and black students, with some of 'the resources and role models they need to get in to the university' and to develop a sense of entitlement, 'that this (elite) university is open to them too'(Engineering outreach co-ordinator: Boston, US). The STEM Summer School in Boston, considered in the previous section (Table 1.), was held at an elite, private university, and recruited students nationally through a competitive application process, identifying high achieving and motivated students from underrepresented groups. It was part of a long running programme which worked with pupils for several years. This and other programmes aimed to support young people in progressing to STEM courses at this elite or similar institutions. On these programmes ambassadors worked closely with groups of school students on subject specific activity. This approach was supported financially by the university and linked to a focus on recruiting more students from these underrepresented groups. Though far less substantial in commitment to individual young people, the G&T events in medicine run at the elite university in London, similarly focused on working with high achieving young people from local state schools to recruit school students from less privileged backgrounds.

These programmes were viewed by organisers in both countries to be very effective. However, they only engaged already high achieving STEM enthusiasts. These strategies may valuably encourage girls and students from underrepresented minority groups to aim for more elite institutions or even apply to study engineering rather than other areas of science. To effectively increase participation in STEM amongst these groups, there is a need to enthuse and engage wider audiences of students who are not already motivated to progress in STEM. This requires a different and more inclusive approach to outreach activity.

### *Working in schools*

A number of outreach programmes in the US study, focused on working in schools. For some, inclusivity was a key ambition, and considered of central importance:

> We want to get to every kid – not just those already into science. (Academic: USA)
> We aim to get women into engineering and broaden participation. We have tried to make certain that everything we do in outreach is designed to broaden participation (Academic: USA)

Whilst campus visits were generally viewed to be more powerful than working in schools, with one academic noting that working in schools meant that young people 'lose the sense of being part of the university', at the US universities there was a shared belief in the importance of 'reaching out' to wider audiences of

young people and this was discussed extensively by academics. This inclusive focus meant that several programmes worked in schools with whole school class or year groups. This inclusive approach to outreach was less evident at the two London universities where the emphasis, driven by funding agendas, was on more targeted engagement with particular underrepresented groups.

Most school based outreach activity considered during the study in the US was limited to one off interactions with groups of pupils. The largest of these programmes extended across several states and focused on a one day science intervention with high school students. On another programme targeting high schools, ambassadors worked with students for only one hour. Whilst these programmes were able to reach, to varying degrees, comparatively large numbers of young people, a number of potential disadvantages were identified. Where programmes only worked with school students for a very limited time, there was concern amongst ambassadors that there was little time to develop relationships. One ambassador observed that 'time restraints is one of the biggest issues we deal with… we only have forty minutes to interact'. Such a brief encounter is unlikely to allow for the sharing of identities found during activities where ambassadors have more time for interaction. Though there is value in young people seeing and hearing from individuals who look like themselves, especially for minority groups who are not well represented at these elite institutions/ on science and engineering courses (Dasgupta 2011), studies have questioned the effectiveness of one off interventions, calling instead for more consistent and sustained approaches (Macdonald, 2014;Archer, MacLeod, Francis & Dewitt, 2020).One inclusive long term school based programme in Boston was led by engineering student ambassadors. Pairs of ambassadors, with the support of engineering academics and school teachers, planned and led a series of sessions for whole classes of elementary/middle school students. These activities focused on problem based learning, engaging school students in a series of activities designed to promote collaboration and team work as well as to support STEM learning and attainment e.g. one class group had to work in teams to construct a Roman style aqueduct to transport water around their classroom. If we consider the 'process', 'location and setting', 'purposes', and 'content' (Colley et al., 2003) of these school based activities, it is evident that ambassadors could be positioned in these learning contexts differently to activities considered previously with more informal attributes. One obvious way in which their positioning differed was in the formal attribute of the school location.

In both countries, schools were key stakeholders and were sometimes influential in the organisation of activity (Gartland, 2014, 2015, 2016). In some instances teachers were keen to use student ambassadors to support the teaching of elements of the school curriculum. At one London university this was found in maths revision workshops where ambassadors worked with borderline C/D students to help them with exam papers. Ambassadors and project organisers in Boston, described how on the elementary/middle school engineering programme, some teachers used ambassadors to teach the engineering components of the school curriculum. The learning in these curriculum focused learning contexts have a number of formal attributes, both in terms of purposes, as the learning is 'designed to meet the externally determined needs of others with more power' rather than being determined by the learner, and in terms of the content', as this is more 'rigidly specified' (Colley et al. , 2003, p. 31). These formal attributes positioned

ambassadors as more like teachers than students which can disrupt younger students' identification with ambassadors as fellow learners (Gartland 2014, 2015). This approach was viewed as less positive for ambassadors. One academic in Boston observed that this was not ideal and 'for undergraduates to have a good experience it's better if it's curriculum enhancement rather than curriculum replacement'.

In school based outreach, ambassadors widely discussed the importance of the active engagement of teachers. Some ambassadors in the US who were working inclusively with whole class groups described working with teachers who had no involvement in planning activity or overseeing lessons and viewed ambassador led sessions as 'time for a break'. This positioned ambassadors as teachers during activities as they were forced into didactic pedagogic approaches (Colley et al, 2003) in their attempt to control classes. Issues with managing pupil behaviour, especially when working with whole classes, were raised widely by US ambassadors, organisers and academics. Classrooms in more deprived areas were noted by various ambassadors and academics as being challenging. In these areas teachers were often seen as less supportive:

> In a lot less affluent areas I've had substitutes and teachers leave – it makes it much harder to win kids over generally. It's almost impossible when teachers leave as the kids don't care as they don't think what you're doing is important (Ambassador: Boston, US)

One group of ambassadors in Boston commented 'the biggest difference (to levels of engagement amongst school students) is demographics, if you are in a middle class area with a good teacher it's easy'. Indeed one of the academics in Boston explained that though the focus of the engineering elementary/middle school programme was to reach diverse and underrepresented groups, schools from affluent areas were included as these provide ambassadors with such positive experiences.

Even on programmes where ambassadors were working with smaller, select groups of young people, leading sessions provided challenges. After school club contexts were viewed as difficult for ambassadors if they are left alone to manage young people. One academic explained how this approach to outreach had been abandoned by the faculty as it had been so unpopular with ambassadors who encountered problems with behaviour and felt they were being left to 'babysit'. Student ambassadors leading an afterschool science club programme in North Carolina discussed the difficulties of asserting their authority with pupils whilst building 'trusting' relationships. One ambassador explained the challenge of the, 'bridge between being a teacher and being a student'. This group of ambassadors contrasted managing behaviour with influencing pupils as peers. They discussed the challenges of juxtaposing managing young people's behaviour with attempting to build friendships and explained 'it is better when someone else is in charge – a leader'.

A difference noted between UK and US outreach activities, is that at universities visited in the US, student ambassadors, with the support of academics and project organisers, were often responsible for developing and leading subject specific outreach activity. This contrasts to most programmes at the universities in London, where ambassadors generally supported activities led and organised by WP teams and other project organisers. Leading activity can position ambassadors

as teachers, potentially creating social distance between ambassadors and school students and discouraging identification (Gartland, 2014, 2015, 2016). However, there are also potential benefits, particularly in facilitating access to activity for large numbers of school students and engaging more young people from disadvantaged backgrounds (Gartland, 2016). Whilst these learning contexts present challenges, ambassadors, academics and organisers identified practices that supported effective outreach activity. As well as university faculty staff and school teacher engagement, the ratio of student ambassadors to pupils was seen as significant to both the ambassadors' experience and their ability to build relationships with school students.

## FUNDING ISSUES AND CONSTRAINTS

There were a number of policies and projects that provided the financial support for outreach activity undertaken at the two London universities during the time of the study, including government funding for STEM activity from the Higher Education Funding Council and funding for general widening participation activity through Aimhigher. The landscape of national funding for outreach activity has changed considerably since the study was undertaken. Whitty, Hayton and Tang (2015) observe that changes in funding under coalition and conservative governments in the UK since 2010 have shifted the focus from generic widening participation strategies to an increased focus on targeting the most able poor students. There has also been a shift to an increased focus on recruitment of these students which has encouraged a very targeted approach to outreach activity, particularly amongst the elite universities (Harrison & Waller, 2017).

The funding of outreach programmes considered as part of the study in the US was different. A number of programmes considered for the study are funded by the US national grant awarding body the National Science Foundation (NSF). The NSF funds research and education in science and engineering in the US through grants and cooperative agreements with universities, colleges and K-12 school systems as well as businesses and informal science organisations. This grant funding has led to the significant interest and engagement of academic faculties, including staff as well as post graduate and undergraduate students. However, issues were identified with grant funding. The outreach activity developed during the lifetime of grant funded projects was not viewed as sustainable when funding ends. Larger funding bodies frequently require proof of impact through assessment and quantitative research studies with controlled trials often favoured. One academic described outreach programmes as being hard to fund 'as we don't have the metrics – some funders want hard data in relation to test scores and progression to engineering' (Academic: Boston, US). There was frustration amongst several US academics that funders 'want a clean' story but that the ambitions of programmes were necessarily complex and multifaceted. In some instances, it was felt that to comply with funders' requirements would prevent reaching underrepresented groups and wider audiences; one academic explained 'we have kept our values at the expense of some funding'. Funding constraints also mean that it is difficult to fund research into programmes to develop an evidence base to garner further funding.

Another source of funding discussed by programme organisers and academics in the US were businesses/ wealthy individuals. An issue raised was that

these funders often want to target particular programs or groups rather than give funding to established outreach activity; one academic explained how such funders like to 'fund specific things'. Such selectivity on the part of funders has implications for the consistency and longevity of programmes. Some activity was funded or part funded by universities themselves. As in the UK, some funding was linked to the recruitment of under-represented groups but additionally in the US universities some funding was focused more generally on promoting community engagement. This activity was largely longer term and seen as more sustainable by programme organisers and provided opportunities for a range of hands on activities that could be open to wide audiences of young people.

In both the UK and US studies, it was clear funding issues make it difficult for universities to run long term sustainable programmes. Funding constraints mean little research is undertaken into projects. There is an emphasis in both countries on proof of impact which poses considerable challenges (Harrison & Waller, 2017). While it may be possible to provide some evidence of correlation between student results / recruitment and engagement on more intensive programmes with small groups of motivated students, such programmes are inevitably selective. To make any claims for the impact of inclusive programmes working less intensively with larger numbers of young people is significantly more challenging. Yet research into outreach activity more generally makes the resounding case for the need for programmes that engage with more, and different students, not just high achievers already on a trajectory into STEM related careers (Macdonald, 2014; Archer et al., 2020).

## CONCLUSION

'Identification with people' is increasingly seen as being more important to encouraging young people to progress in STEM subject areas than simply participating in STEM activity ( Macdonald, 2014; Rodd et al, 2013; Archer et al., 2020). Ambassadors are widely assumed to be 'role models' for young people due to their proximity in age and life stage. However, this is not an automatic process; learning contexts and intersecting aspects of student ambassadors' and pupils' identities are significant to the relationships they are able to develop. Learning contexts with many 'informal attributes' where ambassadors and pupils are positioned as peers, working collaboratively on hands on activity, have been found to be effective in supporting identification between schools students and ambassadors (Gartland, 2014, 2015), potentially encouraging progression into further study in STEM subjects.

Working with small groups of school students on university campus is widely viewed as effective in promoting HE and STEM identities. However, universities often do not have the capacity to engage in this way with large numbers of young people and there is an urgent need to engage wider audiences of young people with STEM. The way outreach activity is funded contributes to making reaching wider audiences of diverse students difficult. However, there is an accepted view that outreach activity should have a wider reach and not simply target young people already interested in STEM careers – 'the brainy few' (Archer et al, 2013; Archer et al., 2020; Macdonald, 2014). Several US programmes worked inclusively with whole classes of school pupils in schools, effectively reaching more young people. However, these learning contexts can have many

'attributes' of formal learning and position ambassadors as teachers, managing difficult behaviour and teaching the school curriculum. This positioning can undermine school students' sense of peer sameness with ambassadors and contribute to dis-identification, yet this extended reach is urgently needed if we are to challenge existing, patterns of participation.

Alongside extending the reach of activity there is, therefore, a need for a sharper focus on pedagogy and better understanding of learning and teaching practices in outreach activity. This engagement with pedagogy is urgently needed in many universities in the UK where a focus on recruitment is often dominant. Examples of outreach practices from the US study suggest that funding mechanisms promoting the involvement of academics and research students can support better informed and more subject specific pedagogy and collaborative approaches. Developing and extending these approaches to outreach activity in both countries could effectively increase the reach and quality of ambassador outreach work. Student ambassadors are a valuable resource that could be effectively used to promote STEM learning with wide audiences of young people in schools but there is a need for a much better understanding of how ambassadors can most effectively be used in these contexts.

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NOTES

[i] The office for Students has asked higher education providers in England for access and participation plans setting out how they will improve equality of opportunity for underrepresented groups to access, succeed in and progress from higher education. The OfS monitors access and participation plans to ensure providers honour commitments made in these plans, and state that action will be taken if providers fail to do so.

[ii] The EAN is described as 'a collaboration of engineering students across universities' that, resonating with the key agenda of the NAE, ' are dedicated to changing the conversation middle and high school students are having about engineering' http://www.engineeringambassadors.com/about.htm

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