2023-10-10

Time To Rethink Engineering Outreach?

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Conference Key Areas: *Engagement with Society & Local Communities: Other [Engineering Education Outreach]*
Keywords: *Engineering Education: Engineering in Schools: Engineering Outreach: National Curriculum*

ABSTRACT

Starting with the research question 'Does engineering outreach work?' this paper looks at the often 'sticky' subject of the validity of engineering outreach in UK High Schools. It examines how Engineering Outreach Activities are conceptualised by external bodies (RAEng., 2016) and critiques the complex range of practical experiential engineering educational interventions offered in school (Neon, 2023, STEM learning, 2023). Drawing upon the findings of, what is, a small single strand of a much larger multi-method, longitudinal analysis of Engineering Education Outreach Activities provided across the West Midlands region of the UK (LBEEP, 2023)], the paper provides a unique insight and descriptive analysis of engineering outreach in schools.

The findings section comprises a comparative analysis of the socio-economic background of schools before looking at the gender breakdown of outreach participants. The various engineering interventions provided are briefly discussed before consideration is given as to how sustainable current engineering outreach activities are. Finally, in questioning whether the UK's current approach of providing engineering education experiences in the form of what are often idiosyncratic, short-term episodic activities, the paper questions the financial, pedagogic and practical wisdom of confining engineering education to 'outreach'. The conclusion suggests that it's time for a sea-change in how we, as a society, teach children and young people about engineering and suggests that perhaps it is time to embed the subject into more established areas of study such as maths and science but also in history and social science.

1. INTRODUCTION

Launched during an unprecedented time in UK (and indeed global) history, the Lord Bhattacharyya Engineering Education Outreach Programme (LBEEP) kicked off at the beginning during the Autumn term of 2020. Midway through a series of 'lockdowns,' the Covid19 Pandemic wreaked havoc across society, resulting in a two-year period whereupon home schooling and working became the norm for many. As few children physically attended school during this time, parents became teachers and teachers were forced to reconceptualize how and what was taught. This had a notable impact on LBEEP. Originally planned to last for five years, to say that the first half of the outreach activities were 'interrupted' by Covid19, would be an understatement. Yet, LBEEP continued. Engineering Education activities were offered during the short periods of time when lockdown was lifted and, in some cases, 'home schooling' activities were offered. This discussion paper reflects upon almost three years of *outreach* activities. Setting the wider context before briefly comparing different activities and considering the sustainability of engineering outreach as part of what schools offer.

2. THE LBEEP ENGINEERING EDUCATION OUTREACH PROGRAMME: WHAT IS PROVIDED TO WHOM?

Located in the West Midlands region of the UK, LBEEP is provided in an area where there are 2,726 Secondary Level Education Institutions. In the region, there are 14 different Local Authorities that are currently responsible for educating 971,332 pupils aged 11-18 years. A socially and culturally diverse area, schools were selected to participate in LBEEP on the basis of the percentage of pupils from higher-than-average number of children from poorer socio-economic backgrounds. One key indicator used in the UK to measure socio-economic background is the percentage of children in receipt of free school meals (FSM). Across England, an average of 22.9% of pupils receive FSM. In the wider West Midlands this figure is 24.4%; whereas in the areas where LBEEP schools are located it is 29.9% (Fig 1).

Figure 1: Local Authorities of the Wider West Midlands Region: Pupils receiving free-school meals (FSM) by gender.

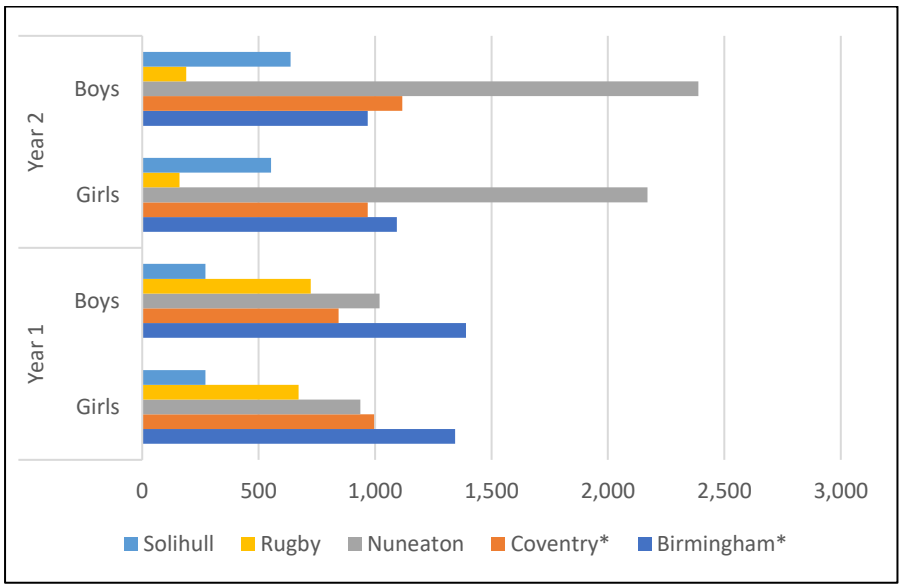
			Number of Pupils			
Local Authority	Number of EIs	Average Percentage FSM	Boys	Girls	All	Percentage of Total
Birmingham*	520	35.2%	107,802	104,327	212,129	21.8%
Coventry*	130	25.4%	30,950	29,684	60,634	6.2%
Dudley	117	25.7%	24,008	22,353	46,361	4.8%
Herefordshire	113	15.2%	12,955	11,858	24,813	2.6%
Sandwell	130	30.1%	31,729	29,613	61,342	6.3%
Shropshire	186	14.2%	22,636	21,864	44,500	4.6%
Solihull*	89	23.0%	20,897	19,672	40,569	4.2%
Staffordshire	446	17.7%	62,898	59,958	122,856	12.6%
Stoke-on-Trent	108	31.8%	20,703	20,407	41,110	4.2%
Telford and Wrekin	85	24.4%	16,636	15,656	32,292	3.3%
Walsall	130	33.0%	27,962	26,764	54,726	5.6%
Warwickshire*	278	17.6%	46,713	44,991	91,704	9.4%
Wolverhampton	121	37.0%	24,944	24,685	49,629	5.1%
Worcestershire	273	18.0%	45,298	43,369	88,667	9.1%
Total	2,726	24.5%	496,131	475,201	971,332	100.0%

*Areas where LBEEP Schools are located

2.1 LBEEP Participating Students: Gender & Geographic Area

Now in its third year, LBEEP has provided a range of outreach activities to high school pupils within its catchment area since September 2020. Whilst participating schools were originally selected before the project began, the numbers of pupils taking part in LBEEP activities varies from year to year. In the first year of the project Birmingham attracted participation from the highest numbers of female and male pupils, in year 2 it was Nuneaton. This is shown below in Figure 2

Figure 2: Geographic Spread of LBEEP & Gender of Participants



2.2 Engineering Focus of LBEEP Activities

LBEEP schools applied for funding to provide numerous engineering-focused learning activities, with Aero-Astro Engineering proving to be the most popular in the first two years of the programme. Perhaps not surprisingly, given the geographic location of the West Midlands, Vehicular & Electro-Electric Engineering also proved popular. Figure 3 shows the number of successful funding applications per activity.

Figure 3: Type of Engineering Covered by LBEEP 2020 / 21 & 2021-2022 (Excluding General Engineering)

	2020-2021	2021-2022
Aero-Astro	**10**	**12**
Computing – Robotics	**8**	**6**
Civil Construction	**4**	**3**
Electrics – Electronics	**9**	**9**
Environment & Sustainability	**5**	**4**
Manufacturing and design	**8**	**5**
Mechanical Engineering	**9**	**3**
Vehicles	**8**	**9**
Other	**9**	**7**

It is important to note that the above displays numbers relating to funding applications in relation to individual schools. In many instances a school applied for funding for several projects, often in the same area of engineering. The number of individual projects offered are better displayed below in Figure 4 as part of the discussion about sustainability which looks at the nature of projects as opposed to the type of engineering funding was applied for.

3. DISCUSSION: IS ENGINEERING OUTREACH SUSTAINABLE?

The importance of providing sustainable engineering outreach activities comes to the fore when examining the numbers of university students studying STEM subjects in general and engineering in particular (Smith et al., 2022). Figure 4 provides an insight into the number of engineering outreach activities offered per year across the programme in terms of sustainability. Column 2 provides an insight into the potential sustainability afforded provided by the activities funded, whilst columns 3, 4, & 5 indicate how many activities were funded in each area per operational year. In classifying the below, the sustainability of activities was classified thus: Socially Sustainable [S] – such projects include sustainability from an educational sense: Economically Sustainable (E): Environmentally Sustainable (Ev).

Figure 4: The Sustainability of LBEEP Funding

	Sustainability	Yr 1	Yr 2	Yr 3
Capital investment	High levels of [E] [S]. Limited [Ev] depending on the nature of individual project	30	30	26
Competition	Limited [Ev] in some – depending on nature of competition. Lacking sustainability in other areas due to necessarily high attrition rates – competitions based on winners at each stage.	17	18	16
STEM club	Limited [S] [E] [Ev] – due to low numbers of participants in individual STEM clubs (tendency to be exclusive)	15	13	10
General curriculum	Capacity for high levels of [S] [E] [Ev] in all areas where funding focused on curricular enhancement.	7	18	8
Externally provided workshop	Little or no sustainability due to bespoke and episodic nature of events	11	7	4
Visit	Little or no sustainability due to bespoke and episodic nature of visit	4	9	2
External talk	Little or no sustainability due to bespoke and episodic nature of talk	2	1	1
Total		54	69	33

This brief insight into engineering outreach encapsulates schools whose student body comprises a higher-than-average percentage of pupils living in socio-economic deprivation (evidenced in Fig 1 showing the percentage in receipt of FSM). This not only makes the need for a sustainable approach to be offered in terms of the future employability of pupils (i.e., Social Sustainability) but also makes the need for the funding to be spent wisely with the needs of future cohorts of children equally as important as those currently enrolled (Social and Economic Sustainability). An analysis of LBEEP applications identified a high number of requests to purchase equipment that can be re-used. This included a range of engineering education ‘kits’, 3D printers and computer tablets (the numbers per year are given in row 2 ‘Capital Investment’. Investing in equipment which can be reused on a longer-term basis suggests a

commitment to longer-term engineering education, indicating that many of the schools adopted a sustainable approach to LBEEP.

In addition to purchasing equipment, a relatively number of the schools entered pupils in 'STEM' competitions, with almost half of the applications in year 3 relating to such activities. As competitions tend to be time-limited, often focused upon a single event or experience, such projects tend to be less sustainable. Indeed, the very nature of a school competition inevitably results in high numbers of 'attrition' (dropouts) at each stage – possibly turning children 'off' engineering for good?

Funding for STEM clubs, which generally attracted lower numbers of pupils account for between one-fifth and just under a third of funding applications across the three years of the project. Whilst sustainable in the sense of continual provision and potential long-term impact on participating pupils, the small numbers of pupils who engage with STEM clubs means that such activities lack social and economic sustainability.

Finally, funding for single visits to local museums and other places of interest such as car manufacturers also necessarily involved a single event as did external funded talks. Again, the sustainability of these activities, in terms of the longer-term impact on young peoples' perceptions and subsequent life and education choices is difficult to determine.

4. CONCLUSION AND RECOMMENDATIONS

This descriptive conceptual paper refers to a small piece of work that is very much an ongoing strand of a much larger project. Concurrently, two PhD theses are exploring the educational impact of engineering outreach. One of the major challenges faced by this programme of outreach is that it started at the same time as the unforeseen Covid19 Pandemic brought the country (and globe) to a standstill. Despite causing unprecedented change to how education was provided over a period of at least 2 years, the research findings thus far suggest that teachers tried their hardest to find a way of providing outreach even when most pupils were being home educated.

In conclusion, the emerging findings from this small study indicate that there is a need for the engineering outreach activities offered under the auspice of LBEEP to continue. However, taking account of the findings and considering broader debates in this area it is not unreasonable to postulate that it may be time for *a sea-change in how we, as a society, teach children and young people about engineering.* Engineering Outreach, even a large programme such as LBEEP can only ever 'scratch the surface' – excluding more pupils than including them.

One important emerging recommendation is that the LBEEP programme be extended to include primary schools. This would enable children to gain some insights into engineering and applied science before they move to high school, hopefully sparking their engineering imaginations a few years ahead of the time when they are forced to select their GCSE options (currently around age 14 years). Moreover, there is little

doubt that *it is time for secondary and primary education to embed engineering into the more established areas of study such as maths and science but also in history and social science.* This would enable children to become aware of the important role played across all areas of society by engineering, whilst providing the means by which engineering imaginations can be sparked at an early age!

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