# Engaging Academics with Outreach: How the 'STEM Connections' model empowers staff

**Phil Jemmett[1], Caroline Cannon[2], Margaret Low[3]**

WMG, University of Warwick, Coventry, UK
Correspondence: [1]Philip.Jemmett@warwick.ac.uk;
[2]Caroline.Cannon@warwick.ac.uk; [3]M.J.Low@warwick.ac.uk
Twitter/X: @philjemmett[1] @megjlow[3]
ORCID: 0009-0002-1998-8728[1]; 0009-0003-3625-2867[3]

**Funding**: See Acknowledgments.

**Editorial review**: This article has been subject to an editorial review process.



## Abstract

*STEM Connections was a funded project designed to position academics at the forefront of outreach activities. It drew on the experience of outreach-focussed professional services staff to bridge the gap between the public and the academy, to train and support academics in the skills of engagement, and to support the design of the activities. Two cohorts (11 in 2022 and 12 in 2023) of academics were trained through this project, creating 20 interactive activities linked to active research and teaching at the University of Warwick. Four academic departments were represented across the two cohorts.*

*This paper explores the background literature of outreach: why do institutions feel a duty to engage the public? Who delivers the outreach? What are the benefits on the institution? Most importantly, how can outreach projects be designed to complement academics' skills, rather than over-burden their already burgeoning workloads? Can outreach projects create tangible benefits for the academics who take part? The paper concludes with reflective statements from the involved academics.*

**Keywords**: STEM outreach; public engagement; science communication; presentation skills; widening participation; outreach

## Introduction

Outreach activity and expenditure is often justified as being a tool for societal change through the impacts that it can have on the audience. The authors' roles in professional services at the University of Warwick provides perspective on the impacts of outreach on the academics who deliver activities. This paper concerns the *STEM Connections* project, reflecting on the theoretical background, design, implementation, and impacts on the academics involved.

### *Why do universities do outreach?*

The common starting point for outreach literature is in 'gaps'. Across all subjects, universities consider gaps between demographics in terms of their applications to, and success in, higher education (HE) institutions. For example, POLAR (the *Participation of Local Areas*) data considers the likelihood of students to enter HE based on their geographical area. Outreach activity may be targeted to serve communities in these areas or other demographic groups. These cases are described as *widening participation* activities, and policy is evolving in response to evidence (**Whitty et al., 2015**).

Universities and funding agencies also emphasise the importance of public engagement and outreach as part of academic activities (**Harris & Ridealgh, 2016**). Funding bids increasingly include descriptions of outreach that will accompany research, for example UKRI have a vision (**UKRI, 2019**) and a strategy case (**UKRI, 2022**) for public engagement. As a Warwick-specific example, the Warwick Electrification Development (WELD) project references the skills gap (**Gammon & Soulard, 2022**). Four researchers on that project were involved in the STEM Connections project. Universities are also including outreach activities as part of REF case studies (**Copley, 2018; Greenhalgh & Fahy, 2015; McLaughlin et al., 2018; Ovseiko et al., 2012; Watermeyer & Lewis, 2018**) and, considering that REF is among the most important metrics to a university's reputation, this demonstrates the strategic value of outreach activities.

Considering science, technology, engineering and maths (STEM) subjects, there is a gap between the perception of science in young children and their older peers. The gradual shift is evidenced in the longitudinal ASPIRES projects (**Archer et al., 2013**). In the minds of young children, the excitement of 'whizz-bang' demonstrations nurtures positivity towards science. As those students progress through education, this excitement fades to the drudgery of equations and textbooks. Enrichment sessions aim to preserve excitement and inspire young people to see themselves as scientists and engineers, aiming to inspire more people to study and enter careers in STEM.

The policy drive to support young people into higher education (**Higher Education and Research Act, 2017**), and specifically those aspiring to becoming STEM professionals arises from an identified 'skills gap' in the UK workforce (**House of Lords Science and Technology Committee, 2022**). There is a shortfall of qualified STEM teachers (**Kirby & Cullinane, 2017**)and, it follows, too few young people are entering the workforce to fill vacancies (**Government Science and Engineering Profession, 2022**). This is a current area of discussion in the literature (**e.g., Banerjee et al., 2024**) but it is not a novel topic, dating back decades (**Cappelli, 1995; D'Amico, 1997; Edgley, 1977; Young et al., 2021**). The gap has not been 'fixed' despite all the initiatives over this time making it abundantly clear that any current work should be well documented and published to establish an evidence base of what works and what the impacts are.

*How much outreach activity is being done?*

With funding bodies, policymakers, University admissions and strategic directions all pushing academics towards outreach, clearly there must be a lot of activity in place.

Activities may be logged in the Higher Education Access Tracker (HEAT) to record what work is done, and with whom. The total number of activities listed against the academic years 2017-2018, 2018-2019 and 2019-2020 were 86,472, 123,424, and 102,387, respectively (**HEAT, 2024**). A major challenge in the sector is how much of this outreach is visible. It is impossible to estimate the proportion of outreach that 'professional' teams are aware of *versus* activity that is done by individual academics on their own, and therefore may not be captured into databases such as HEAT.

Discussions between the staff assigned to outreach in departments can be rare, and the authors imagine that few faculties are aware of all the outreach activity within their own departments, let alone their university.

*Who does outreach?*

Professional teams and roles for the co-ordination of outreach and widening participation exist within the university sector. Departments may have nominated members of staff who are tasked with widening participation in addition to research and teaching (**Johnson et al., 2019**). There may be a formal plan in place for these members of staff to target specific recruitment criteria, given the existential need for departments to recruit. In other institutions widening participation may not take place without the award of external funding:

> *In advocating for the standardization and embedding of student transitions support, the issue of who does this work comes to the fore. In the case of our project, internal funds paid for each of the three authors to work on the project for half a day per week for approximately nine months. If we hadn't successfully bid for this funding, then the project would not have taken place.* (**Breeze et al., 2020**).

Universities may have central teams, in some cases multiple teams, who each have a different perspective on outreach. There are networks that link multiple universities, such as UniConnect hub and draw on decades of student data (**Rose & Mallinson, 2020**). They target activity to widen participation in HE (**Rose & Mallinson, 2023**).

Undergraduate students are often brought in to outreach activities as ambassadors (**Fleming & Grace, 2016; Gartland et al., 2010**), as content creators (**Iriart et al., 2022**), as event supporters (**Struthers & McConnell, 2023**), or as event leaders (**Stirling et al., 2018**). There are benefits to the outcomes and skills of students as a result of taking part in these schemes (**Fogg-Rogers, Lewis, et al., 2017; Muñoz-Escalona et al., 2019; Nelson et al., 2017**). Undergraduate students can be more relatable role models than established STEM professionals, being closer in age to school pupils. The additional benefits to the employability skills of the undergraduates, especially considering that these students may themselves have come from a widening participation background, could support their progression into, and success in, STEM professions.

Lastly, and perhaps most importantly for the context of this paper, there are individual academics. In some cases, academics feel so passionately about their subjects that they volunteer to speak in public spaces. In many cases these activities go unknown to their institution and are lost to the national picture of public engagement. Alternatively, academics may work with the teams above to contribute their expertise and content to a university-known programme, wherein their efforts should be recognised and contribute towards a promotion pathway.

## Literature Review

*Designing projects that benefit academic institutions.*

Impacts of outreach interventions on the audience include admissions (**Sithole et al., 2017**), perception of the university (**Bryan et al., 2022**), and the role of the university in the local community (**Charles, 2003**), but there are additional benefits to the institution itself.

Frameworks defining a university's intended direction may be used to inform the design of an outreach activity and might be considered homogeneous across institutions. For example, outreach activities can be

featured as case studies in the Research Excellence Framework (REF) (**McLaughlin et al., 2018**); the Knowledge Exchange Framework includes 'public and community engagement' as one of seven key metrics (**UKRI, 2023**); and the Knowledge Exchange Concordat gives 'engagement' as one of its eight guiding principles. Additionally, the Teaching Excellence Framework is cited as one reason for academics to get involved with outreach activities as it '*offers significant scope for impact on subsequent work in higher education, particularly with regard to pedagogy'* (**Johnson et al., 2019**).

These recognised markers of impact and success in academia can be incorporated into the design of an outreach project, which is where the support of *'professional public engagement support staff'* can be of benefit (**Watermeyer & Lewis, 2018**).

A unified approach to capturing impact would allow a clearer picture of the benefits of outreach to institutions. However, consolidating individual activities from disparate projects into shared 'measures of success' is difficult. Beyond the number of attendees at events, few outcomes are shared between all types of activity. Practitioners should be aware of the need to capture and demonstrate impact, and how these impacts contribute towards a larger national picture.

*How can outreach contribute towards a co-ordinated national drive?*

In the simplest sense, outreach needs to be captured and recorded for it to benefit beyond the individual session. Eilam et al., (**2016**) describe two approaches: *bottom-up* and *top-down*. A bottom-up approach grows organically from an academic's networks and their passion to deliver content. While this is admirable, to ensure activity has maximum benefit, isolated activities need to be brought into a cohesive whole. This can be achieved through a top-down model: aligned with university strategy and conceived as part of a larger project.

Long-term planning is needed to ensure projects can be measured effectively. If the aim is to inspire young people to apply to HE, an intervention aimed at 10-year-olds must wait 8 years to see results. Funding for projects of this length is rare, and this is cited as a particular barrier to the success of STEM interventions by Rincon and George-Jackson (**2014**).

With hundreds of institutions, third-party providers, charities, and more delivering outreach across the country, sharing knowledge and collaborating is vital. A landmark study from the Royal Academy of Engineering suggested that collaboration across the sector is a key component of an effective national offering (**Royal Academy of Engineering, 2016**).

From our own data within WMG at the University of Warwick, roughly 10% of staff participate in one outreach activity per year (internal data). Given there are roughly 230,000 academics employed within the UK[i], estimating that 23,000 academics take part in one outreach or public engagement activity each year is not unreasonable.

If outreach is to achieve positive societal change and do more than 'make up the numbers', the outreach must be of a high quality, drawing from a body of knowledge shared between outreach practitioners across institutions. For example, the Office for Students commissioned research into standards to support practitioners in evaluating outreach (**Office for Students, 2019**). To effectively use these standards, there needs to be a system in place to develop and support academics, their skills, and the content they deliver.

Examining the literature, one finds a great many articles about outreach projects. However, much of the literature focuses on the audience who receive the intervention and not on the academics who deliver it.

*How are academics being supported and trained?*

In a letter from the executive publisher of *Science*, Leshner states:

> *University science departments should design specific programs to train graduate students and postdoctoral fellows in public communication* (**Leshner, 2007**)

These training programmes must, however, also be available and valuable to all academics for the university to be able to deliver the grand societal aims of widening participation.

Training must deliver the skills needed to engage a young audience. Young people respond strongly to real life examples and stories (Locklear, 2014). Academics should embrace this and consider themselves as role models for the academic career. Role models are proven to inspire young people in specific subjects (**Nowiński & Haddoud, 2019**), in overcoming assumptions about subjects (**Bonny, 2018; Henri et al., 2023**), and in the widening participation context (**Heaslip et al., 2020**). A key difference between schoolteachers and outreach practitioners in their pedagogical approach is the role of personal stories in delivery (**McCauley et al., 2018**).

An important tool to contextualising complex ideas (such as technical academic knowledge) is storytelling. Storytelling has proven effective in several outreach projects (**Bik et al., 2015; Clarke et al., 2023; Fogg-Rogers, Sardo, et al., 2017**) but does require training to develop (**Rubegni et al., 2023**). Making academic content transferrable to everyday life, through weaving a story-like narrative into the content, facilitates

conversations outside of the intervention, which in turn supports the development of science capital (**Archer et al., 2013**).[ii]

Given that so many academics take part in outreach, it is logical to bring likeminded individuals together to share their experiences with each other. Donner and Wang (**2013**) describe a community-based approach where sessions work best with *'peer-to-peer … sharing of challenges and best practices, hands-on modelling of an activity where participants can observe best practices being implemented, reflection about the rationale behind the practice, and time to adapt the strategy to participants'.* Another example aimed to create a community of academics who could '*share their story'* with positive impacts on the audience (**Peeples et al., 2017**).

Innovative approaches to outreach can create a richer experience for the academics as well as the students involved. For example, approaches utilising drama as part of engineering (**Green et al., 2020**) and chemistry (**Kerby et al., 2010**) education boosted the confidence of academics and their ability to present to different audiences, while building links between the arts and sciences.

*How does outreach benefit academics?*

A comprehensive outreach programme does place additional work and pressure on institutions, which may be considered a burden (**Watermeyer, 2011; Weir, 2004**). This makes it important to reframe the benefits of outreach from recruiting students to the university towards the benefits to the person delivering activities. Shifting our attention from institution-wide benefits to individuals should be considered in the planning stage.

Firstly, we can consider how outreach can be made easier, to reduce pressures and workload considerations on the research and teaching staff. Workload is cited as a significant barrier to academics' involvement in outreach (**Khan & Siriwardhane, 2021**). To address this, some institutions have a dedicated member of staff in position in each department to bridge between academia and the school education system, which is presented as a positive case by Johnson et al., (**2019**). It should be noted that, in some cases, the only viable way for a department to resource outreach is for a member of existing academic staff to co-ordinate it as a part time additional responsibility. In these cases, networks of similar staff across the institution could provide opportunities for collaborative practice that reduce workload.

One way of minimising the additional pressure placed on academics who devote time and resources to outreach is to design activities that deliver academic value in a format that adds value to their careers.

Two key aspects of academic life, research and teaching, may be bolstered by a lively outreach programme. Papers written by academics describing projects, proving the academic rigour and pedagogy in their outreach, are an obvious metric of academic success (**e.g., Struthers and McConnell, 2023**). Outreach may also be drawn on to inspire and improve teaching (**Illingworth & Roop, 2015**). In some cases, public dialogue may steer the direction of research or be crucial to its success, which relies on there being a two-way flow of communication. Citizen science, for example, directly draws on the experience of the public to gather data (**Bell et al., 2016; Hosie et al., 2024; Murray et al., 2017**).

Next, the recognition that is awarded to academics for contributing towards a university's public-facing goals. Outreach contributions should be used as evidence for applications for fellowships, awards, and promotions. In many cases, all three of these list 'impact' as a category that requires evidence. Recording contributions to outreach activities should certainly count towards this. Work has been undertaken in the UK (**Macfarlane, 2007**), Australia (**Smith et al., 2014**), and the USA (**Chang, 2000**) to ensure that outreach activity aligns with promotion criteria. The University of Warwick has 'Impact, Outreach, and Engagement' as one of the sections of the promotion pathway (**University of Warwick, 2024**). However, it is important to recognise that capturing impact can be challenging and add additional pressure. Templates, models of best practice, and sharing experience can help to ensure that impacts are captured effectively and efficiently.

## The STEM Connections Model

Drawing on the literature precedent, the STEM Connections approach was designed to train and develop academic staff to deliver outreach activities. It can be broken down into four stages: *training*, *development, delivery,* and *legacy*.

### *Training*

The project built a community of academics who shared ideas and practice with each other. Academics were recruited from across the university's Science, Engineering and Medicine faculty. Cohort 1 comprised 11 academics and Cohort 2 comprised 12, representing 4 departments.

Cohort 1 received two days of training, while Cohort 2 received three days of training. Training sessions from third-party providers focussed on how to include personal elements into their presentation and weave storytelling techniques throughout. Both cohorts received a full day of training at Coventry Transport Museum provided by CV Life, drawing on the expertise of the museum to engage diverse audiences, adapting their presentations to match the needs in the room.

### *Development*

A project Co-ordinator role was incorporated into the bid to build the community, and lessen the workload required to plan the activities themselves.

The Co-ordinator arranged '*Tinker and Tea'* sessions, where components, tools, gadgets, *etc*. were available for academics to explore how they could build a new prop to explain their field of interest. The demonstrations and props were developed to capture the interest of the audience, allowing the presenters the opportunity to discuss their topic easily and weave their own personal story in.

An additional role of the Co-ordinator was liaison with schools and arrangement of which presenters were available to present at each school.

### *Delivery*

Details of the pedagogy and teaching of the STEM Connections project will be described in another paper.[iii] In short, a *School Roadshow* was organised to provide a 'training ground' for the academics to practise their skills and work with their demonstration. In these roadshows, 4 academics set up in a school hall and groups of students rotated between these academics every 10 minutes, experiencing a range of different topics. The Co-ordinator played the role of host and provided a solid platform for the academics to present from, handling questions, timings, and floor management. This allowed the academics to focus entirely on the group in front of them. Following the *School Roadshow*, every academic on the programme was provided a space in Coventry Transport Museum for a takeover event called the *Showcase*. In the *Showcase*, around 100 students (per event, one for Cohort 1 and another for Cohort 2) rotated around the academics moving through the museum's galleries. Each activity was matched to the theme of the gallery: with materials science demonstrations directly below an exposed car chassis, a demonstration of generating electricity with a hand crank in a gallery of bicycle history, *etc*.

### *Legacy*

A project website was populated with interview videos of each academic answering questions about their back-story and motivation to enter STEM careers. Cohort 2 also recorded a video version of their demonstrations. These video resources were supported by 'do-it-at-home' versions of each demonstration, alongside explanations of the technology involved, and its applications in the real world. These resources are freely available on the STEM Connections project website.[iv]

Each academic was provided with their videos and professional photography (headshots and at events) to use for any profile-building purposes.

The outputs of the project are included in the WMG Outreach annual reports, presented at the International Research Culture Conference 2023 and at the Engineering Education Research Network 2023 conference.

Funding continuity[v] was a challenge to establishing the legacy of this project. The two cohorts were funded through separate application processes with no guarantee of success. Had there been a continuous period of funding a crossover period between the two cohorts could have been designed wherein mentoring and knowledge exchange could have occurred.

## Reflections

A group of academics now have a ready-to-go activity that can be used at a variety of events. This supports our existing outreach activity, as well as other groups at the University such as the Warwick Institute of Engagement. In total, STEM Connections demonstrations have been used at 25 separate WMG events (internal data, not including activity delivered for other departments).

Reflection is an important stage in the pedagogical approach to outreach (**McClure et al., 2020**), informing future delivery. Staff in both cohorts were asked to reflect on the process and how it had impacted them. These reflections are broken down by which cohort the academic was in and divided into topics. Firstly, **Table 1** below reflects on the value of producing materials that can be used multiple times in an outreach context, rather than delivering in one school and never used again.

*Table 1: Quotes from academics relating to the delivery of the materials produced in STEM Connections outside of the initial project scope*

| Topic | Quote | Cohort |
|---|---|---|
| Value of the materials to existing university activities. | *The demonstrators have been used at open days and have gone down very well with staff and students. It has led to the [department] making our own demonstrators on wider topics for open days and outreach activities.* | 1 |
| Inspiration to continue to engage with outreach activities. | *Often researchers are left on their own to put together their own outreach projects, but are insufficiently funded and supported, making outreach seem too daunting to try.* | 1 |
| | *STEM connections allowed us to partner with experts in PE who helped us shape our rough ideas into something tangible and achievable in only a few weeks- this really built my confidence in building something of my own and challenged me to see my research from new angles. It really had a huge positive impact on my skills as a science communicator, which led* | |

| | |
|---|---|
| | *me to apply for grants of my own to take the work I did with STEM connections to new schools and science festivals- something I wouldn't have dreamed of doing before the project.* |

Open days are an important contribution towards university admissions, so additional value that has been added to these by the materials produced in STEM Connections is a boon to the institution itself. The second quote reveals that the staff involved were motivated and inspired to continue with outreach activities and empowered to deliver on their own after the project.

The developed activities are also useful outside of the context of outreach. **Table 2** (below) contains reflections related to the impact of STEM Connections on academic teaching.

*Table 2: Quotes from academics relating to impacts on university teaching*

| Topic | Quote | Cohort |
|---|---|---|
| Teaching practice changes through working with a non-university partner. | *I have learned a lot during the project. Mostly thanks to the training sessions that we had (one in Coventry Transport Museum and the one in the University's conference centre). These training sessions were very practical and informative. I have learned about the importance of student engagement. I can apply the knowledge I gained not only in doing outreach activities but also in my day-to-day teaching.* | 1 |
| Teaching practice changes after delivering outreach activities to new audiences. | *The challenge (which was very different to my usual day-to-day activities at the university) was to boil a very complicated subject down to its very essence and then give a (very) short presentation all whilst ensuring it was fun, interactive and engaging. This is no mean feat I can tell you (especially as the children weren't shy about letting you know if you got it even the tiniest bit wrong), but it has definitely helped to sharpen my ideas about teaching subject matter to my students here at Warwick.* | 2 |
| Use of produced materials during undergraduate lectures. | *STEM Connections has given me opportunities to translate my theoretical knowledge in [subject area] to practical demonstrations which I widely use in my [subject] modules at the University of Warwick ... I learned about public engagement from WMG STEM Connections team and use the transferrable skills to develop creative and innovative teaching practice in the field ... This teaching method has inspired significant classroom interactions and a few out-of-box thinking questions from the students which forms the basis for interactive classroom style learning and enhanced student engagement.* | 2 |

Finally, **Table 3** (below) contains a selection of quotes on other aspects of the project, which the academics felt were of benefit to them. These do not fit one fixed theme, but in each case are interesting points to learn from. A reflection on the value of the community adds legitimacy to the approach taken in STEM Connections to create cohorts in terms of developing the materials, but it had additional benefits in that academics felt that the project was a valuable networking opportunity outside of

outreach. Technical staff were engaged in the project to ensure that materials produced were of a high quality. The project team have worked with technical staff extensively, with great benefit to the work that we are able to deliver, so their engagement was part of our culture of working to begin with. However, this is not the case universally across all institutions, but the tide is turning towards recognising the value of technical staff at universities. This is captured in one quote in the table (**Table 3**).

*Table 3: Quotes from the academics on other outcomes of the project*

| Topic | Quote | Cohort |
|---|---|---|
| Working in a community of like-minded individuals. | *Throughout the whole process, the STEM Connections team and my fellow participants was really very supportive and that also made it fun to be part of – it was nice getting to network with members of staff I wouldn't ordinarily meet and also to find out about all the different research that taking place at the university.* | 2 |
| Networking and publicity. | *It's been really good to meet other academics from WMG and other departments of the university that are involved in Outreach, really good to try different tech for outreach activities and enjoyable to attend workshops for getting better at STEM demonstrations and public speaking. The publicity has also benefitted my personal career profile.* | 1 |
| Working with technical staff. | *The STEM Connections project has illustrated what is possible … when we engage technical staff. [It] has set the standard on training provision, departmental engagement and engaging non-academic staff.* | 1 |
| Enjoying the project. | *I enjoyed the creative, practical side of the project. The fact that I could design and build something new from the scratch was exhilarating. I also loved the time we spent with the children. They have been extremely enthusiastic. Their curiosity and engagement made me feel excited about science again. Seeing children discover new scientific ideas was fascinating.* | 1 |

## Discussion and Recommendations

From the authors' perspectives, STEM Connections was an enjoyable exploration of a range of topics. Since the academics were sharing their personal motivations while presenting their areas of expertise, their passion was plain to see. The community built across both cohorts is an energetic and inspiring group, who continue to contribute to their departments' reputations. The authors whole-heartedly encourage the reader to consider whether an outreach project that brings together a group of outreach-interested-but-inexperienced academics with an outreach 'professional' could work in their context. Importantly, activity

should be designed to keep the academic at the forefront of the delivery and in the spotlight for any media coverage.

The above sections can be summarised into elements of outreach that are crucial to maximising benefit to the academics and to the university (**Table 4**).

*Table 4: Crucial Outreach Elements for Maximising Academic & Institutional Benefits*

| |
|---|
| Academic staff should be offered training and support to deliver effective outreach. |
| Professional outreach staff can help to manage the workloads of academics by being involved with co-ordinating the activities. |
| These outreach teams should also ensure that activities are delivered to the target audiences that matter to the University's strategy. |
| Individual activities should contribute towards a larger project and form a cohesive body of work towards a defined aim. |
| A community of academics and outreach staff should be built to ensure that knowledge is shared, and work is collaborative in nature. |
| Activity should be documented and visible, celebrating the academics who delivered the work. |
| Activity should be documented and visible, celebrating the academics who delivered the work. |
| The focus of the activity should be on the *experience* the young people have, and not the content that is delivered. |
| Academics should embrace their position as role models when speaking to young people and may include elements of their personal stories in their content. |

Reflections from the cohorts of academics demonstrate the design of STEM Connections supported these aims. Following the success of this model the authors are seeking funding to continue the project and they are sharing the approach and learnings from it. They are continuing efforts to embed outreach into department and institutional strategies.

## Acknowledgements

The contributions of the academics who made up the two STEM Connections cohort must be recognised. Their exceptional commitment to producing high quality demonstration pieces and presenting them so wonderfully at events made this event what it is. Thank you to Farah Villa-Lopez, Alex Baker, Tishtrya Mehta, Rohin Titmarsh, Fanfu Wu, Magdalena Cieslak, Antonia Betzou, Kevin Couling, Claire Dancer, Tom Goodman, Mona Faraji Niri, Jiaqi Duan, Ishwar Kapoor, Jose Ortiz Gonzalez, Umair Paracha, Robin T. George, Xinkai Tian, Piotr Mazurkiewicz, Magdalena Rybak, Piotr Klin, Adriana Smith Ortiz, Karen Kudar, and Negar Riazifar.

Partnering with a local cultural institution, CV Life, provided a unique perspective on our engagement activities and how we ran workshops. We would like to thank them for their invaluable expertise.

The Co-ordinator role for the first cohort of the project was Rebecca Swan-McAdam and her efforts were vital in the success of the early stages of the project.

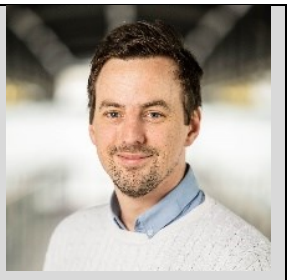
The demonstration pieces were made possible by the technical expertise of the WMG Technical Services team. Their insight into designing, using, and manufacturing all elements of the props and demonstrations is gratefully acknowledged.

*Funding*

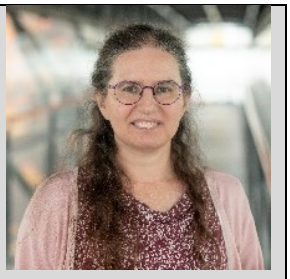
STEM Connections was funded by the Enhancing Research Culture Fund through Research England.

Jose Ortiz Gonzalez, Xinkai Tian, Umair Paracha, and Robin T. George were additionally supported by the WELD (Warwick Electrification Deployment) project. The WELD programme is funded by Driving the Electric Revolution, an ICSF Challenged delivered by UK Research and Innovation. Project Number: 10033186.

Phil Jemmett has a Ph.D. in chemistry but left the lab to share science and inspire young people. He has delivered events in libraries, museums, community groups, schools, universities, and once in someone's lounge. Phil works at WMG at the University of Warwick with experts in cutting-edge technologies, sharing their stories with young and old to build trust in science and engineering. After all – if people don't trust the researchers making innovations, the products won't make it out of the university. Phil believes inspiring the workforce of the future to go into engineering is key to building a green future.



Caroline Cannon is a textiles expert having worked in the fashion industry from testing PPE equipment to designing garments with unusual materials like paper. She then moved into teaching Design and Technology and so has a deep understanding of how young people think about materials, their properties, and their applications. Since joining WMG to support the STEM Connections project Caroline has worked with academics to find a practical way to demonstrate their areas of expertise to the widest possible audience, and with teachers to put a new twist on how we run outreach events with schools.



Margaret Low works with young people encouraging them to become creators as well as consumers of technology in her role as Director of Outreach and Widening Participation for WMG, University of Warwick. Margaret's interactive workshops explore creative aspects of technology. She collaborates with organisations and communities to explore inclusive, creative learning experiences using technology. Margaret has decades of experience in creating a culture of outreach within a university. Her contributions to the sector were recognised in 2021 when she was awarded an MBE for her services to public engagement and widening participation in the Queen's Birthday honours.

## List of Tables



## References

Archer, L., Osborne, J., DeWitt, J., Dillon, J., Wong, B., & Willis, B. (2013). *ASPIRES Report: Young people's science and career aspirations, age 10-14*. Available at: https://kclpure.kcl.ac.uk/ws/portalfiles/portal/64130521/ASPIRES_Report_2013.pdf [Accessed: 26 January 2024].

Banerjee, P., Graham, L., & Given, G. (2024). A systematic literature review identifying inconsistencies in the inclusion of subjects in research reports on STEM workforce skills in the UK. *Cogent Education*, *11*(1). DOI: 10.1080/2331186X.2023.2288736 [Accessed: 26 January 2024].

Bell, J., Chesebrough, D., Cryan, J., & Koster, E. (2016). Museum–University Partnerships as a New Platform for Public Engagement with Scientific Research. *Journal of Museum Education*, *41*(4), 293–306. DOI: 10.1080/10598650.2016.1228302 [Accessed: 26 January 2024].

Bik, H. M., Dove, A. D. M., Goldstein, M. C., Helm, R. R., Macpherson, R., Martini, K., Warneke, A., & Mcclain, C. (2015). Ten Simple Rules for Effective Online Outreach. *PLoS Comput Biol*, *11*(4). DOI: 10.1371/journal.pcbi.1003906 [Accessed: 26 January 2024].

Bonny, S. M. (2018). Effective STEM Outreach for Indigenous Community Contexts-Getting it Right, One Community at a Time! In *International Journal of Innovation in Science and Mathematics Education* (Vol. 26, Issue 2).

Breeze, M., Johnson, K., & Uytman, C. (2020). What (and who) works in widening participation? Supporting direct entrant student transitions to higher education. *Teaching in Higher Education*, *25*(1), 18–35. DOI: 10.1080/13562517.2018.1536042 [Accessed: 26 January 2024].

Bryan, R., Gagen, M. H., Bryan, W. A., Wilson, G. I., & Gagen, E. (2022). Reaching out to the hard-to-reach: mixed methods reflections of a pilot Welsh STEM engagement project. *SN Social Sciences*, *2*(2). DOI: 10.1007/s43545-021-00311-6 [Accessed: 26 January 2024].

Cappelli, P. (1995). Is the "Skills Gap" Really About Attitudes? *California Management Review*, *37*(4), 108–124. DOI: 10.2307/41165813

Chang, Y.-B. (2000). Evaluation of Outreach for Promotion and Tenure Considerations: Views from University Faculty. *The Journal of Continuing Higher Education*, *48*, 3–13. DOI: 10.1080/07377366.2000.10400409 [Accessed: 26 January 2024].

Charles, D. (2003). Universities and Territorial Development: Reshaping the Regional Role of UK Universities. TITLE, *18*(1), 7–20. *Local Economy: The Journal of the Local Economy Policy Unit*. DOI: 10.1080/0269094032000073780 [Accessed: 26 January 2024].

Clarke, T., Castro-Sotomayor, J., Vachta, K., & Seidel, D. K. (2023). Building a collaborative, university-based science-in-action video storytelling model that translates science for public engagement and increases scientists' relatability. *Front. Commun.*, *7*. DOI: 10.3389/fcomm.2022.1049648 [Accessed: 26 January 2024].

Copley, J. (2018). Providing evidence of impact from public engagement with research: A case study from the UK's Research Excellence Framework (REF). *Research for All*, *2*(2). DOI: 10.18546/rfa.02.2.03 [Accessed: 26 January 2024].

D'Amico, C. (1997). Back to the future: A current view of workforce 2000 and projections for 2020. *Employment Relations Today*, *24*(3), 1–11. DOI: 10.1002/ERT.3910240302 [Accessed: 26 January 2024].

Donner, J., & Wang, Y. (2013). A National Strategy to Build STEM Education Systems. *Afterschool Matters*, *17*, 50–57. https://files.eric.ed.gov/fulltext/EJ1003842.pdf

Edgley, R. (1977). Education for Industry. *Educational Research*, *20*(1), 26–32. DOI: 10.1080/0013188770200104 [Accessed: 26 January 2024].

Eilam, E., Bigger, S. W., Sadler, K., Barry, F., & Bielik, T. (2016). Universities Conducting STEM Outreach: a Conceptual Framework. *Higher Education Quarterly*, *70*(4), 419–448. DOI: 10.1111/HEQU.12105 [Accessed: 26 January 2024].

Fleming, M. J., & Grace, D. M. (2016). Agents of aspiration: the (often unintended) benefits to university students working in outreach programmes. *Educational Research*, *58*(3), 300–318. DOI: 10.1080/00131881.2016.1185316 [Accessed: 26 January 2024].

Fogg-Rogers, L., Lewis, F., & Edmonds, J. (2017). Paired peer learning through engineering education outreach. *European Journal of Engineering Education*, *42*(1), 75–90. DOI: 10.1080/03043797.2016.1202906 [Accessed: 26 January 2024].

Fogg-Rogers, L., Sardo, M., & Boushel, C. (2017). "Robots Vs Animals": Establishing a Culture of Public Engagement and Female Role Modeling in Engineering Higher Education. *Science Communication*, *39*(2), 195–220. DOI: 10.1177/1075547017696169 [Accessed: 26 January 2024].

Gammon, P., & Soulard, J. (2022). *The Role Universities Play in Meeting Industry's Electrification Skills Shortage*. IEEE Transportation Electrification Council. Available at: https://tec.ieee.org/newsletter/december-2022/the-role-universities-play-in-meeting-industry%E2%80%99s-electrification-skills-shortage [Accessed: 26 January 2024].

Gartland, C., Hawthorne, H., & McLoughlin, C. M. (2010). Discourses, identities and learning: Implications for the training of student ambassadors in engineering. *Engineering Education 2010: Inspiring the Next Generation of Engineers, EE 2010*, 2010. Available: http://www.hestem-sw.org.uk/upload/student-ambassadors-1.pdf [Accessed: 26 January 2024].

Government Science and Engineering Profession. (2022). *Government Science & Engineering (GSE) Profession Talent Strategy 2021 – 2023*. https://www.gov.uk/government/publications/government-science-engineering-gse-profession-talent-strategy-2021-2023/government-science-engineering-gse-profession-talent-strategy-2021-2023 [Accessed: 26 January 2024].

Green, N., Fry, J., Wood, J., Gartside, R., & Mohamed, A. (2020). DAUGHTERS OF INVENTION: USING DRAMA TO ENGAGE CHILDREN WITH ENGINEERING. *48th Annual Conference on Engaging Engineering Education, SEFI 2020*, 1269–1279. Available at: https://research.birmingham.ac.uk/en/publications/daughters-of-invention-using-drama-to-engage-children-with-engine [Accessed: 26 January 2024].

Greenhalgh, T., & Fahy, N. (2015). Research impact in the community-based health sciences: An analysis of 162 case studies from the 2014 UK Research Excellence Framework. *BMC Medicine*, *13*(1). DOI: 10.1186/s12916-015-0467-4 [Accessed: 26 January 2024].

Harris, P., & Ridealgh, K. (2016). Academic involvement in Outreach: Best practice case studies from health and languages. *Widening Participation and Lifelong Learning*, *18*(3), 74–83. DOI: 10.5456/wpll.18.3.74 [Accessed: 26 January 2024].

Heaslip, V., Hutchings, M., Collins, B., Crowley, E., Eccles, S., Hunt, C., Tooth, R., & Wardrop, A. (2020). Situating the evidence for impact of outreach strategies: A systematic review for improving access to higher education. *Widening Participation and Lifelong Learning*, *22*(1), 25–54. DOI: 10.5456/wpll.22.1.25 [Accessed: 26 January 2024].

HEAT. (2024, January 23). *Higher Education Access Tracker*. Available at: https://heat.ac.uk/ [Accessed: 26 January 2024].

Henri, D. C., Coates, K., & Hubbard, K. (2023). I am a scientist: Overcoming biased assumptions around diversity in science through explicit representation of scientists in lectures. *PloS One*, *18*(7), e0271010. DOI: 10.1371/journal.pone.0271010 [Accessed: 26 January 2024].

Higher Education and Research Act, c. 41 (2017). Available at: https://www.legislation.gov.uk/ukpga/2017/29/part/1/crossheading/access-and-participation/enacted [Accessed: 26 January 2024].

Hosie, A., Firdaus, M., Clarkson, J., Gupta, E., Laidlaw, L., Lamont, T., Mooney, M., Nevin, G., Ramsay, C., Rutherford, S., Sardo, A. M., Soulsby, I., Richards, D., Stirling, D., West, M., & Goulao, B. (2024). Citizen science to improve patient and public involvement in GUideline Implementation in oral health and DEntistry (the GUIDE platform). *Health Expectations*, *27*(1), e13921. DOI: 10.1111/hex.13921

House of Lords Science and Technology Committee. (2022). *Action needed across Government to secure a high-skilled STEM workforce for the UK*. Available at: https://committees.parliament.uk/committee/193/science-and-technology-committee-lords/news/175105/action-needed-across-government-to-secure-a-highskilled-stem-workforce-for-the-uk/ [Accessed: 26 January 2024].

Illingworth, S. M., & Roop, H. A. (2015). Developing key skills as a science communicator: Case studies of two scientist-led outreach programmes. *Geosciences (Switzerland)*, *5*(1), 2–14. DOI: 10.3390/geosciences5010002 [Accessed: 26 January 2024].

Iriart, V., Forrester, N. J., Ashman, T. L., & Kuebbing, S. E. (2022). The Plant Science Blogging Project: A curriculum to develop student science communication skills. *Plants People Planet*. DOI: 10.1002/PPP3.10287 [Accessed: 26 January 2024].

Johnson, M., Danvers, E., Hinton-Smith, T., Atkinson, K., Bowden, G., Foster, J., Garner, K., Garrud, P., Greaves, S., Harris, P., Hejmadi, M., Hill, D., Hughes, G., Jackson, L., O'Sullivan, A., ÓTuama, S., Perez Brown, P., Philipson, P., Ravenscroft, S., … Williams, S. (2019). HIGHER EDUCATION OUTREACH: EXAMINING KEY CHALLENGES FOR ACADEMICS. *British Journal of Educational Studies*, *67*(4), 469–491. DOI: 10.1080/00071005.2019.1572101 [Accessed: 26 January 2024].

Kerby, H. W., Cantor, J., Weiland, M., Babiarz, C., & Kerby, A. W. (2010). Fusion science theater presents the amazing chemical circus: A new model of outreach that uses theater to engage children in learning. *Journal of Chemical Education*, *87*(10), 1024–1030. DOI: 10.1021/ED100143J [Accessed: 26 January 2024].

Khan, T., & Siriwardhane, P. (2021). Barriers to career progression in the higher education sector: Perceptions of Australian academics. *Sustainability (Switzerland)*, *13*(11). DOI: 10.3390/su13116255 [Accessed: 26 January 2024].

Kirby, P., & Cullinane, C. (2017). *Science Shortfall*. Available at: https://www.suttontrust.com/our-research/science-shortfall/ [Accessed: 26 January 2024].

Leshner, A. I. (2007). Outreach training needed. In *Science* (Vol. 315, Issue 5809, p. 161). DOI: 10.1126/science.1138712 [Accessed: 26 January 2024].

Locklear, J. G. (2014). Ms. Hines and the sick 5th graders - Making hands-on outreach and learning about the environment engaging through the use of case stories! *ASEE Annual Conference and Exposition, Conference Proceedings*. DOI: 10.18260/1-2--22852 [Accessed: 26 January 2024].

Macfarlane, B. (2007). Defining and Rewarding Academic Citizenship: The implications for university promotions policy. *Journal of Higher Education Policy and Management*, *29*(3), 261–273. DOI: 10.1080/13600800701457863

McCauley, V., Martins Gomes, D., & Davison, K. G. (2018). Constructivism in the third space: challenging pedagogical perceptions of science outreach and science education. *International Journal of Science Education, Part B: Communication and Public Engagement*, *8*(2), 115–134. DOI: 10.1080/21548455.2017.1409444

McClure, M. B., Hall, K. C., Brooks, E. F., Allen, C. T., & Lyle, K. S. (2020). A pedagogical approach to science outreach. *PLoS Biology*, *18*(4). DOI: 10.1371/journal.pbio.3000650 [Accessed: 26 January 2024].

McLaughlin, J., Boothroyd, L., & Philipson, P. (2018). Impact arising from sustained public engagement: A measured increase in learning outcomes. *Research for All*, *2*(2). DOI: 10.18546/rfa.02.2.04 [Accessed: 26 January 2024].

Muñoz-Escalona, P., Rigmand, D., & Dunn, M. (2019). Increasing Science Capital: Engineering Students Inspiring and Engaging New and Future Generations. In J. Andrews, G. Knowles, & R. Clark (Eds.), *The Proceedings of the 7th Annual Conference of the UK & Ireland Engineering Education Research Network* (pp. 150–157). WMG, University of Warwick. Available at: https://warwick.ac.uk/fac/sci/wmg/news-and-events/events/wmgevents/eern/proceedings_13_dec.pdf [Accessed: 26 January 2024].

Murray, J. K., Casey, R. A., Gale, E., Buffington, C. A. T., Roberts, C., Kinsman, R. H., & Gruffydd-Jones, T. J. (2017). Cohort Profile: The "Bristol Cats Study" (BCS)-A birth cohort of kittens owned by UK households. *International Journal of Epidemiology*, *46*(6). DOI: 10.1093/ije/dyx066 [Accessed: 26 January 2024].

Nelson, K., Sabel, J., Forbes, C., Grandgenett, N., Tapprich, W., & Cutucache, C. (2017). How do undergraduate STEM mentors reflect upon their mentoring experiences in an outreach program engaging K-8 youth? *International Journal of STEM Education*, *4*(1). DOI: 10.1186/s40594-017-0057-4 [Accessed: 26 January 2024].

Nowiński, W., & Haddoud, M. Y. (2019). The role of inspiring role models in enhancing entrepreneurial intention. *Journal of Business Research*, *96*, 183–193. DOI: 10.1016/j.jbusres.2018.11.005 [Accessed: 26 January 2024].

Office for Students. (2019). *Using standards of evidence to evaluate impact of outreach*. Available at: https://www.officeforstudents.org.uk/publications/standards-of-evidence-and-evaluating-impact-of-outreach/ [Accessed: 26 January 2024].

Ovseiko, P. V., Oancea, A., & Buchan, A. M. (2012). Assessing research impact in academic clinical medicine: A study using Research Excellence Framework pilot impact indicators. In *BMC Health Services Research* (Vol. 12, Issue 1). DOI: 10.1186/1472-6963-12-478 [Accessed: 26 January 2024].

Peeples, T. L., Peterson, T. R., Nyaema, M. K., & Newhall, B. (2017). Engagement in Practice: Increasing the Researcher/Inclusion Staff Collaboration Culture for Inspiration of Diverse Learners in Science Technology Engineering and Mathematics (STEM). *2017 ASEE Annual Conference & Exposition, 2017*. DOI: 10.18260/1-2--28233 [Accessed: 26 January 2024].

UKRI. (2022). *Research and innovation for all: UKRI's public engagement strategy*. https://www.ukri.org/publications/ukri-public-engagement-strategy/research-and-innovation-for-all-ukris-public-engagement-strategy/

Rincon, B. E., & George-Jackson, C. E. (2014). *STEM intervention programs: funding practices and challenges*. DOI: 10.1080/03075079.2014.927845

Rose, A., & Mallinson, L. (2020). Raising aspirations for non-traditional students through Higher Education outreach activities: A review of literature relevant to the Uni Connect programme. *Journal of Higher Education Research* , *3*(1), 1–22. DOI: 10.5456/WPLL.24.3.113 [Accessed: 26 January 2024].

Rose, A., & Mallinson, L. (2023). Assessing the impact of regional transformative outreach activities aimed at widening university access, and participation among under-represented groups in schools. *Widening Participation and Lifelong Learning*, *24*(3), 113–139. DOI: 10.5456/wpll.24.3.113 [Accessed: 26 January 2024].

Rubegni, E., Penzenstadler, B., Landoni, M., Jaccheri, L., & Dodig-Crnkovic, G. (2023). Owning Your Career Paths: Storytelling to Engage Women in Computer Science. In J. Vallverdú (Ed.), *Gender in AI and Robotics: The Gender Challenges from an Interdisciplinary Perspective* (Vol. 235, pp. 1–26). Springer.

Sithole, A., Chiyaka, E. T., Mccarthy, P., Mupinga, D. M., Bucklein, B. K., & Kibirige, J. (2017). Student Attraction, Persistence and Retention in STEM Programs: Successes and Continuing Challenges. *Higher Education Studies*, *7*(1), 46–59. DOI: 10.5539/hes.v7n1p46 [Accessed: 26 January 2024].

Smith, K. M., Else, F., & Crookes, P. A. (2014). Engagement and academic promotion: A review of the literature. *Higher Education Research and Development*, *33*(4), 836–847. DOI: 10.1080/07294360.2013.863849 [Accessed: 26 January 2024].

Stirling, C. J., Camacho Rosales, A. L., Donko, A. L., Baktash, N., Grabska, K., Posner, M. T., Prentice, J. J., & Clarke, D. T. (2018). *Student-led outreach and public engagement activities at the University of Southampton to celebrate the inaugural International Day of Light*. 10. DOI: 10.1117/12.2320304 [Accessed: 26 January 2024].

Struthers, A., & McConnell, S. (2023). Improve children's legal knowledge and skills through School Tasking: your time starts now. *Law Teacher*. DOI: 10.1080/03069400.2023.2282860 [Accessed: 26 January 2024].

UKRI. (2023). *Knowledge Exchange Framework Decisions for the third iteration Knowledge Exchange Framework*. Available at: http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/ [Accessed: 26 January 2024].

UKRI. (2019). *UKRI Vision for Public Engagement*.

University of Warwick. (2024). *Academic Promotion*. Available at: https://warwick.ac.uk/services/humanresources/internal/academicprocesses/academicpromotion/ [Accessed: 26 January 2024].

Watermeyer, R. (2011). Challenges for University Engagement in the UK: Towards a Public Academe? *Higher Education Quarterly*, *65*(4), 386–410. DOI: 10.1111/J.1468-2273.2011.00492.X [Accessed: 26 January 2024].

Watermeyer, R., & Lewis, J. (2018). Institutionalizing public engagement through research in UK universities: perceptions, predictions and paradoxes concerning the state of the art. *Studies in Higher Education*, *43*(9), 1612–1624. DOI: 10.1080/03075079.2016.1272566

Weir, C. (2004). The Marketing Context. Outreach: Luxury or necessity? *Journal of the Society of Archivists*, *25*(1), 71–77. DOI: 10.1080/0037981042000199160 [Accessed: 26 January 2024].

Whitty, G., Hayton, A., & Tang, S. (2015). Who you know, what you know and knowing the ropes: a review of evidence about access to higher education institutions in England. *Review of Education*, *3*(1), 27–67. DOI: 10.1002/REV3.3038 [Accessed: 26 January 2024].

Young, E., Wajcman, J., & Sprejer, L. (2021). *Where are the women? Policy Briefing-Full Report*. Available at: https://www.turing.ac.uk/sites/default/files/2021-03/where-are-the-women_public-policy_full-report.pdf [Accessed: 26 January 2024].

**To cite this article:**

Jemmett, P., & Cannon, C., & Low, M., 2024. Engaging Academics with Outreach: How the 'STEM Connections' model empowers staff. *Exchanges: The Interdisciplinary Research Journal*, 11(3), 139-160. Available at: https://doi.org/10.31273/eirj.v11i3.1544.

## Endnotes

[i] Statistics taken from the HESA website: www.hesa.ac.uk

[ii] During the editorial review process the editor noted: "An interesting consideration is that in a very sweeping way those in the STEM subjects tend to not be those who are very comfortable with the more performative elements of contextualising knowledge for a wider audience - a really interesting example of recognising this is the Alda centre (https://aldacenter.org/) which works to bring acting techniques to STEM academics to deliver their knowledge to wider audiences." The authors agree with this point and think that it merits wider discussion than this note allows. See also Green *et al*. (2020).

[iii] This will appear in upcoming Conference Proceedings for the Engineering Education Research Network.

[iv] These resources can be found at: www.warwick.ac.uk/stemconnections.

[v] The funding for this project was provided for an initial nine-month window for a single cohort. A separate application for a second cohort was made roughly three-months after the end of the first project with confirmation of funding coming roughly three-months after that. The two cohorts were funded and run over the same time of year (January-July). An application for a third project cohort was unsuccessful. While the project team worked hard to build overlap and peer-to-peer sharing between the two cohorts to ensure continuity, the significant gap in timing between the two cohorts reduced the possibility of building links between the communities.