Participant-centred planning

Framework for effective gender balance activities in tech

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ABSTRACT

The gender imbalance in the tech industry [21], mirrored in computing education [13], is problematic in terms of providing appropriate products and services for the whole population. This lack of diversity and inclusion is also self-perpetuating through gendered stereotypes of computing and women's experience of male-dominated work and study environments [4; 7].

Activities to break this cycle aim to encourage women and girls to study computing and pursue careers in digital [18]. This paper presents a new tool: a framework to support teams to design successful activities.

The research study aimed to identify factors for success, with a particular focus on using of role models. A typology survey was designed to capture structured descriptions of activities; an online survey asked female and non-binary computing students about their role models and motivations for choosing computing, including any activities to encourage them into computing/STEM; and organisers from successful initiatives were interviewed. The study revealed a wide range of activities, with many potential success factors, but a dearth of rigorous evaluation. The Participant-Centred Planning Framework was developed from the study's findings. Its aim is to support effective design of engaging activities, and collect evaluative evidence over time.

This framework was successfully piloted with organisers of initiatives to encourage girls into computing/STEM. Pilot study participants appreciated the framework's structure, guidance, and participant-centred paradigm. The study indicated that the framework could also support activities targeting other currently underrepresented groups.

This paper presents the initial study, the pilot, the framework, and plans to extend its use.

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CCS CONCEPTS

• Social and professional topics → computing education

KEYWORDS

Gender balance; role models; women; stereotypes; evaluation; EDI

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1 Introduction

HESA data for UK Higher Education (HE) records 21% of computing students as female in 2020/21, rising slightly from 20% the year before [14]. Meanwhile about a quarter of tech professionals in the UK are women [21]. However, living in technologically-saturated societies, all genders have a stake in designing and controlling digital technology. Digital skills are essential to participate fully in society, increasing economic, social, and democratic opportunities, personal agency and choice [24]. Further, diversity in teams making and managing digital technologies is essential in order to avoid producing tools which amplify biases in society and neglect the needs of, for example, women and people of colour. Currently, many of life's essential technologies are designed to fit men, rather than women, from smart phones to PPE [23; 5], and bias can tip into discrimination, as in Amazon's (abandoned) AI-driven recruitment engine, which had taught itself to downgrade women's job applications [6].

So, how can we, as computing educators and researchers, encourage women and girls to study computing and consider

careers in tech? This paper introduces a tool to support this work. The Participant-Centred Planning Framework derives from our research into effective ways to increase gender balance in computing, with a particular focus on using role models. The framework supports people organising activities to focus on the needs of participants and integration of evaluation plans through every one of six aspects of planning. The six core aspects are: aims; participants and inclusion; promotion; activity; role models and next steps. The framework is designed to be used by busy teams to create effective events while minimising additional overheads. It has been successfully piloted and we share it here to document its genesis and encourage its uptake. Ultimately, our aim is to collect enough data about gender balance initiatives in tech to provide evidenced accounts of what works in which context. In the meantime, we describe the research which led to the framework, starting, through the literature, with the basis for using role models to encourage people from underrepresented groups to consider Computing (and STEM more widely), through data gathering and analysis, to revisions of the framework and the pilot study. Finally, limitations of the research and plans to take the framework forward are discussed.

2 Role models for diversity and inclusion in HE

Before exploring the use of role models to increase women's participation in computing, we need to briefly dismiss suggestions that women have a natural aversion to computing or an innate deficiency in necessary skills like maths. Saini [19] has comprehensively debunked ideas that women are, on average, worse at maths, and anything that requires systematic thinking due to their brain structures (gender essentialism [22]) or our evolutionary past. Rather, she evidences how biased research, within male-dominated sciences, has propagated distorted views of women and helped to keep women out of science. Meanwhile, Hicks' history of women as computers and programmers [15] records how women were the preferred sex for number crunching before the personal computer, due to their diligence, accuracy, and lower pay rate; then becoming the early operators of computers in industry, as a natural extension of their admin roles. In this context, women's current underrepresentation in computing seems to derive from sociocultural pressure, manifested in stereotyped ideas about women and men's roles, goals, and careers [2; 8], combined with stereotypes about the culture of computing [4]. Role models are suggested as an effective way to combat these stereotypes [18].

Role models are increasingly suggested as ways to support widening participation in Higher Education (HE), particularly attracting and retaining students from underrepresented groups, and especially into STEM subjects [e.g., 11], as they have the potential to counter stereotypes [4; 18] and provide positive examples [1].

Stereotypes portray people in computing as "geeky", socially awkward and infatuated with technology, while the work is portrayed as not collaborative or socially useful, and the values favour masculine interests and celebrate the lone genius trope [4]. These unattractive factors are compounded with stereotypes around girls' abilities, for example that they struggle more with maths than boys do [4]. The stereotypes act as gate keepers, deterring women from the field [4], especially as women are socialised to prefer careers that are collaborative and help people [8]. Cheryan's research, using actors as stereotyped or counter-stereotyped computing students, revealed that these stereotyped characteristics can have a negative affect on female students' feelings about studying computing, regardless of the gender of the actor / role model. The impact of stereotypes permeates environments, e.g. via classrooms with "Star Trek posters, science fiction books, and stacked soda cans" [4, p.5]. Notably, a sizeable proportion of women in Cheryan's United States-based studies (20-25% of participants) preferred the stereotyped environment, so broadening the narrative about what it means to be a computer scientist, through diversity and variety, is key, rather than a blanket "de-geeking".

In the context of STEM education, Gladstone and Cimpian [11] define role models as "individuals who can positively shape a student's motivation by acting as a successful exemplar" [p.2]. Their systematic review aims to identify which role models are effective for which students, in terms of encouraging their progress in STEM. So, in the studies they review, they identify characteristics of role models (their perceived competence, their similarity to the student, and the attainability of their STEM career) and characteristics of students (gender, race/ethnicity, age, and identification with STEM). Rather than leading recommendations for specific student groups, their findings lead them to recommend how to maximise role models' effectiveness, according to their work and social identities. Role models should be portrayed as competent and successful, but within the realms of the achievable, as seemingly unattainable success may demotivate students. Meaningful similarities between the role models and students may be around attitudes or hobbies, as much as social groupings. Role models from underrepresented groups have the broadest positive effect, regardless of the characteristics of the students.

Gibson [9] identifies that individuals (e.g. students) conceive of people as role models by identifying the attributes they need for learning, motivation and inspiration, and to help define their self-concept. Individuals are not passive recipients of role modelling; rather they are likely to take different attributes from different role models to create composite role models: a kind of portfolio. Following Markus and Nurius [17], this portfolio of possible selves may include negative role models (things to avoid) as well as positive. However, Grande [12] notes that in some non-English languages, the term for role model precludes negatives: e.g. in Swedish and Spanish the term translates as "model to follow". Grande finds "it is the emulator who defines another person as a role model" [p.6] and proposes a model encapsulating external perspectives as well as embodied characteristics. Role models possess achievements (which may be viewed objectively or subjectively) and aspects (competencies; character attributes; and attitude/ behaviours).

Empirical studies with measurable effect [18] include Alvarado and Judson's [1] evaluation of the Grace Hopper Celebration, where young women (participants) interacted with female role models (diverse women in computing) and were significantly more likely to choose a CS major afterwards, measured by survey

preference *and* enrolment patterns. In Hanesworth's [13] analysis of approaches to tackling gender imbalances in further and higher education, role models are popular within broader strategies as a method for raising awareness and aspirations and encouraging applications. However, while intended outcomes are recorded and measurable, actual impacts are rarely evidenced. This is the impetus for this study's investigation into initiatives to tackle gender imbalance in computer science education.

3 Methodology

3.1 Research questions and approach

Commissioned by a government body to investigate the use of positive role models to recruit women into technology-related study, our research questions were:

1. What are the key features of successful initiatives to encourage girls and women to consider study and careers in computing?
2. Who are the role models in these initiatives and what characteristics and actions have positive effects on participants' aspirations towards studying computing?

The initial focus was conscious use of role models by Educational Institutions (EIs), especially in further and higher education, in Scotland. This was broadened out to include outreach activities and unconscious use of role models beyond EIs (adding charities and industry). Three components formed the methodological approach:

1. A typology of role model initiatives;
2. A survey of computing students and apprentices;
3. Case study interviews about successful initiatives.

A privacy impact assessment was completed and comprehensive ethics and data management strategies were agreed across the project partners. All research participants were provided with information about how their data would be used and stored and asked to record their consent.

3.2 Typology of role model initiatives

A typology of role model initiatives to encourage participation in computing was created, based on a literature review and refined through an online focus group with organisers of such initiatives. The focus group was recruited by the project partners and funding body emailing people we knew who were involved in relevant initiatives. The typology consisted of 23 components to describe the details of each initiative. These included items related to: aims and objectives of activity; target participants and inclusion; organisations and leadership; activity type, delivery and environment; role models' activities and profiles; costs/ resources / materials; evaluation, tips, and future plans. This was implemented as an online survey, including multiple choice and open (free text) questions, using survey logic for more detail. Each component was labelled according to whether answers would be public or private. The survey tool is still open for submissions. It is available here, along with the public components of the collected initiatives: https://ada.scot/role-models/.

3.3 Survey of students and apprentices

Anticipating a lack of evaluative evidence in the collection of data about role model initiatives, we surveyed existing female computing students to establish role model influences on their study choices. The online survey included questions about: demography; their programme and previous education; career plans and reasons for choosing digital; experience of role models and any initiatives to encourage young people to study STEM; and students' parent/ guardian's occupations (digital, STEM, other). The survey was reviewed by a focus group (recruited in the same way as the previous one) and piloted with five female computing students, with revisions after each. The survey was then promoted to female students and apprentices in further and higher education, gaining 269 valid responses.

3.4 Interviews about successful initiatives

We identified four cases where organisations had some success in increasing the number of women and girls choosing computing subjects and also supporting female computing students:

1. High school teacher encouraging girls into computing;
2. Organisation dedicated to supporting women in and into STEM;
3. Award-winning outreach and support to increase equality in a UK university's computing department;
4. UK university computing department which doubled its intake of female students.

We interviewed five leaders from these cases, online, drawing out the main features, underlying strategies, and tips for success from these compound initiatives. Interviews were recorded and transcribed.

3.5 Analysis

The typology survey garnered 16 responses describing 15 diverse initiatives. Of these, only three reported a relatively formal evaluation; five had none or none specified; five had informal or poor responses; two had not evaluated yet. This did not provide enough data to identify key features for success, though it highlighted that implementing evaluation was difficult in this context. For example, first time events may struggle to design effective evaluation and / or persuade participants to complete feedback surveys. Quantitative analysis of the student survey data provided a broad picture of women's journeys into studying computing, their perceptions of influential role models in that process, and their experience of relevant initiatives.

Qualitative data from all three instruments, including open text responses to the initiatives survey and student survey, plus transcripts of the case study interviews, was imported into NVivo and analysed, as one cohesive dataset of heterogeneous perspectives, using qualitative content analysis [16]. Categories [10] were derived from the typology of initiatives, reflecting the

main sections. The texts were coded iteratively by one researcher, adapting the categories to reflect the contents of the text (e.g. the perspectives of the student survey respondents). The researcher was female, had completed degrees in both arts and computing subjects, and also organised several gender balance initiatives. The final categories were: Student Needs, Strategic Aims, Target Audience and Inclusion, Activities, Role Models, Evaluation, Impact on Students, Things to Avoid. A further category, Gender Imbalance, was added to collate personal experiences of gender imbalance and bias. Data assigned to each category was analysed to identify the perspectives of the respondents in a primarily inductive and descriptive approach. These perspectives were summarised and added to the framework, as described below, for example as "What worked for participants?" or "Tips/ ideas from organisers". Quotations were added as "Comments" to ground each aspect of the framework in the lived experience of young women. For example, from the Activities category: "Generally leave having learned something and feeling inspired. These events are very inclusive, friendly and inspirational."

4 Findings

As noted above, the initiatives typology survey did not garner enough entries to provide robust evidence. It did indicate a healthy landscape of diverse initiatives, coming out of industry, EIs, and publicly-funded projects. The few projects which implemented relatively formal evaluations reported success in terms of uptake and feedback. Notably, these were larger projects which had been running for some time, with their own dedicated staff.

The student survey gathered the experiences and perspectives of female and non-binary students who had decided to study computing and related subjects at further or higher education level. Half the respondents had studied digital technologies at high school and, of these, 69% were taught by a female computing teacher. The 2020 national census records 49% of secondary school computing teachers in Scotland as female [20]. In the qualitative survey responses, teachers were the most-referenced role models who had influenced career plans, followed by family members, and 17% of respondents reported that a teacher first inspired their interest in digital technologies. When asked specifically if they had a role model that influenced their career plans, 42% of respondents agreed they did. Of these, only 44% of the role models were women. So, the gender of a person may not be of particular importance for them to be considered a role model for women in computing. For example one respondent said: "I don't care what someone's gender is, if they did great things then they are someone to look up to. Their gender is irrelevant." And another said: "I search for both men and women that have gone on my same path and learn from them so I can do the same". However, female role models were recognised for their ability to break down stereotypes. One respondent commented: "The most memorable and helpful thing was the presence of women who worked at these companies, and them explaining their career paths and talking about their current day to day work. It also just helped to see a real life example of women working in the field I wanted to work in, just to be able to get a mental image."

In total, 46% of respondents had participated in some kind of initiative. All initiative types were influential on average (i.e. scoring 3+ on a 1-5 scale from 1: not at all influential; to 5: extremely influential). The most influential were competitions, mentoring, and courses/training/summer schools. These types of initiative are more active and hands-on and would typically provide participants with some form of evidence or specific encouragement that they are capable in computing; i.e. they would boost confidence and increase self-efficacy. For example, one participant said: "GCHQ Girls competition - we were really successful, which made me believe I was actually good computing, rather then just an enjoyer of it." However, some respondents were wary of gendered initiatives, suggesting they perpetrated stereotyping and/or bias; rather women just needed equality of opportunity.

Another finding that came out of the survey was the isolation participants felt in computing courses. We provided a space at the end of the survey for participants to tell us anything else they wanted to about their experience in digital tech. Many wanted to tell us about being the only women in their courses and classes. For example: "I felt a little intimidated as it made me realise that there probably wasn't going to be any girls in my college course, it made me feel more anxious than anything else." And "I sometimes feel the need to work harder, because I am worried that I might be seen as someone who doesn't have enough knowledge and that it's going to be tied to my gender."

Finally, the case study interviews provided holistic and reflective pictures of successful approaches, including their motivation and strategies, leadership, activities, and impacts. The cases included a great variety of role models, for example:

- *Women in Tech Wall* in the classroom, with images and quotes from women who are prominent in the digital world or computing history;
- #ThisIsWhatASTEMinistLooksLike — a social media campaign where women posted photos of themselves in their work environment;
- Tea-time socials for female students and staff, featuring visiting high-profile female professors of computing;
- Modules which included students going to work with young people in schools on a project;
- Gender-balanced panels with people working in tech, because women students were particularly interested in how technology is used in the world;
- Funding female students to attend international conferences for women in computing, such as Grace Hopper Celebration.

"Top Tips" common across case studies emphasised the importance of a personal approach, such as talking to students individually; dedicated and involved support from leadership and colleagues; integration and mainstreaming; clarity of aims; and ideas about what participants would need next.

Having categorised the texts from the inputs according to the main elements of the typology of initiatives (as described above) and considered the findings from quantitative analysis of the

student survey, a framework was created to support people organising initiatives. An iterative process of collaborative review and revision then took place, including workshops with the project's steering group and other stakeholders, plus an initial pilot by some of the research team to support the design of an initiative to support women in computing education. The aim of these initial reviews and revisions was to produce a consistent and easy to use framework for the formal pilot. This is the framework described below. An outline of the formal pilot study follows the description of the framework.

5 Participant-Centred Planning Framework

The framework puts participants at the centre: who are organisers trying to engage, and what is the change they wish to see in those participants following the event? The six aspects of the framework are: *Aims* (aims for participants and strategic aims); *Participants and inclusion*; *Promotion* (reaching target participants); *Activity*; *Role models*; and *Next steps*. Evaluation is integrated throughout. This ties the evaluation to the aims of the initiative (i.e. the impact on participants); it also encourages organisers to consider good practice data collection from the beginning and to try to gather some feedback within the initiative itself, rather than relying on post-event surveys.

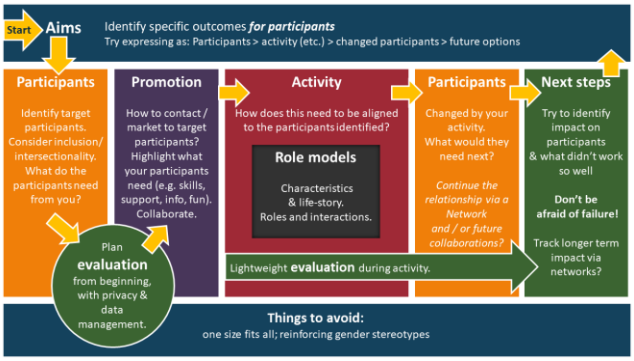

Figure 1: Best practice card

Recognising that most organisers are already extremely busy, the framework starts with a flow chart, which distils the main points into a schedule to follow, in the form of a *best practice card* that could be pinned to the wall [Figure 1]. This is followed by *checklists* for each aspect, to support people to think through their planning in more detail [Figure 2]. Each checklist is a table, about a page long, of questions, examples, suggestions, tips from organisers, and comments from the research which contextualise the planning with lived experience. Each checklist also includes an evaluation section, linking that aspect of planning to relevant evaluation suggestions. For example, the *Participants and inclusion* checklist includes the following evaluation tips:

- Plan data management (privacy and consent) carefully and early.
- What data will you need to collect about your participants?
- Collect demographic data sensitively.

5. Role Models

5. Role Models	
Who are they?	**What do they do?**
Considerations: gender, age, ethnicity, background, achievements, aspect (e.g. friendliness, positivity). ❖ Diverse people working in the tech industry; ❖ Diverse professors and students; ❖ Staff helping out, e.g. lecturers, researchers, teachers (any gender).	Demonstrate that women can be successful in computing and tech industries, ➢ by example (if female); ➢ by taking participants / girls seriously (e.g. helping them develop a skill, answering lots of questions). Also, offer support and encouragement and create friendly communities.
What worked for participants?	**Tips / ideas from organisers**
✓ Seeing women succeed and hearing how they got there. ✓ Finding out about real jobs and opportunities. ✓ Being encouraged and mentored. ✓ Organising their own communities and networks. ✓ A change from being in male-dominated environments.	✓ Integrate, e.g. female student ambassadors at open days; women in history of tech when learning concepts. ✓ Boys don't seem to mind if speakers are male or female. ✓ Role modelling enforces your endeavour, rather than being an end in itself. ✓ Invite people personally. ✓ Consider yourself a role model.
Evaluation	**Comments**
❖ Ask helpers how you can reward them. ❖ Get feedback from guests and helpers too. ❖ Establish relationships and networks, for support, evaluation, and future participation.	"They have a friendly personality. Don't make the occupation feel out of reach and don't talk 24/7 jargon." "I enjoyed this because they had very different backgrounds and neither had set out to work in STEM so their stories and experiences were interesting." "It made me a lot more confident as a woman wanting to pursue a career in a rather male dominated field." "Guest speakers are the most impactful when they talk about what they had to do to get where they are and often when they don't come from a digital technology background how they broke into it." "Look, these are the jobs, if you haven't heard about them already. These are all the amazing women doing them."

Figure 2: Checklist for Role Models

The checklists are colour-coded to the best practice card. For example, the *Role Models* checklist [Figure 2] has charcoal borders, aligned to the charcoal box about Role models at the centre of the best practice card. The final page draws out *quick questions* from the six checklists, adding space to encourage organisers to actively answer the questions and to record their decisions. These can be used to focus team discussions, keep priorities straight, and record what was decided to inform future events. Further, a shared repository of answers to these questions would help to identify what activities are most successful for attracting women and girls into computing and support organisers to create better events.

6 Pilot study

A pilot study was conducted to test the framework in practice and gather input on the most appropriate format, plus recommendations for strategies to make the framework and evidence base sustainable over the longer-term, ensuring people continue to find out about it and adopt its use.

The framework was packaged as a Microsoft Word document and a PDF including a page of instructions for use and invitations to join the pilot. The pilot included two streams of organisers (live and retrospective) who provided feedback via online workshops, plus an online focus group of stakeholders more specifically concerned with identifying the best ways to promote the framework's use. The live stream included four pilot projects using the framework to support their organisation of diverse initiatives: to encourage young people's interest in data science; to encourage school leavers to apply for tech training; to encourage attendance at an online event showcasing female computer scientists; and to support women studying computing and working in tech through peer mentoring. The retrospective stream included experienced organisers of five initiatives to encourage young people, especially

girls, into computing/STEM, such as coding clubs and connecting businesses with schools.

Feedback on using the framework was gathered via two online workshops (one for each stream). Both workshops followed the same protocol which structured the group discussions; first investigating the organisers' use of the framework and then looking at ways to support users and mainstream its use. Organisers in the retrospective team were asked to reflect on the framework in light of the initiatives that they had recently implemented. The discussions were recorded via MS Teams and in text notes by the facilitators; then combined into documents which summarised the workshop participants' responses to the protocol questions.

The feedback was broadly positive: the framework was considered useful, both by more and less experienced organisers. It helped to keep participants and inclusion at the forefront of organisers' minds and also surfaced conversations about role models and about evaluation. In planning activities, it supported cross-referencing with the team for consistency of approach. For example, some project teams held meetings in which they discussed details of their plans according to the framework and recorded their decisions within the quick questions section. It was suggested that the framework would be especially useful to introduce new team members to the planning. Most of the retrospective organisers felt that they would not have time to actually record answers to the quick questions, especially those who were constantly delivering initiatives at scale. However, the organisers of the live pilots found them valuable, though some small clarifications were suggested. Also, two live pilots did not actively use the best practice card.

An online resource was suggested as a useful way to access the framework, for example to click through from the best practice card to the more detailed checklists. The resource could also hold case studies, examples of evaluation methods and tools, and downloads. While collecting responses to the quick questions could build into a valuable resource, organisers needed something more flexible in terms of being able to access and change their answers easily; also, the relative convenience and privacy of recording answers on a Word document or on paper might support more accurate responses. Organisers were wary of complex, unreliable, difficult to understand digital applications that would add to their already considerable workload.

Everyone involved in the pilot was keen that the framework be promoted and its use encouraged and supported. For example, an aligned 'tech for good' funding competition could impel use of the framework by applicants. Webinars and workshops would support its use, with case studies of use prioritised to show that the framework is useful and effective. In the longer term, partnerships with established organisations and networks would expand the user base. One of the live pilot participants commented: "It's such a valuable resource it would be good to get it out there and share it."

The framework aims to support evaluation in three ways: promoting in-event evaluation (while participants are present); planning post-event evaluation in advance (e.g., so that necessary data is collected in line with GDPR and evaluation planned before organisers run out of steam / resources); and third, building a database of initiatives plus their evaluations. For light touch, in-event evaluation, organisers requested suggestions for good in-situ methods. They appreciated the importance of planning all evaluation from the start and integrating it with aims. Longitudinal analysis, for example the impact of an event on later applications to study computing, is challenging on an individual initiative basis. However, a concerted national uptake of the framework, including a record of initiatives, could have impact that would show on a national level in terms of, for example, girls choosing to study for qualifications in computing at school, college, and university.

7 Limitations of this research

A large collection of structured descriptions of relevant initiatives, based on our typology would provide more rigorous data about what works in each context. The framework has potential to support this collection. As completing the typology for an initiative takes about an hour, organisers could benefit from some additional help or incentive to complete. For example, data could be gathered via interviews or added collectively in an editathon. The qualitative content analysis of data underlying the framework was rather instrumental, aimed at informing the framework, rather than identifying analytic patterns across the dataset. A reflexive thematic analysis [3] might uncover more nuanced meanings. A researcher with different expertise or life experiences may have categorised texts differently.

8 Conclusions and recommendations

There is a great deal of enthusiasm around improving the gender balance in computing education and the tech industry, to bring good career opportunities to more women, improve work and study environments, and ultimately produce better and more inclusive products. However, more evidence is needed about what works in which contexts to avoid wasting goodwill and valuable resources, such as organisers' and participants' time. This research investigation aimed to identify effective practice in initiatives to encourage women and girls into computing, especially around the use of role models. It became apparent that evaluation of gender balance activities is difficult, often omitted, or limited to simple satisfaction feedback. So, a framework was created, based on this investigation, which would support effective planning, with evaluation integrated into the plans. This participant-centred planning framework was then piloted with organisers of relevant initiatives and found to be useful and helpful.

The next stages involve creating an online resource, including case studies of use and a collection of in situ evaluation methods. Workshops and webinars to promote and support use will feed into the collection of case studies and start to mainstream use of the framework. The first workshop will be held at UKICER'22.

The framework promotes best practice in engagement, which should lead to improved and more successful activities. Over time, a centralised collection of evaluations of a large-enough range of initiatives will establish key features of effective initiatives. Finally, this robust and supportive approach to development and evaluation will lead to increasing numbers of girls choosing to study computing subjects, year on year, until gender balance activities are unnecessary.

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