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How to cite:

Glover, Alison; Harries, Stuart and Jones, Martin (2018). An evaluation of a project aimed at increasing participation of young women in STEM activities and training in Wales. *International Journal of Gender, Science and Technology*, 10(3) pp. 432–440.

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Version: Version of Record

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International Journal of
Gender, Science and Technology

<http://genderandset.open.ac.uk>

An evaluation of a project aimed at increasing participation of young women in STEM activities and training in Wales

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ABSTRACT

This case study reports on the delivery and impact of a European Union funded project in Wales. STEM Cymru 2 encourages participation in engineering activities and improvements in Science, Technology, Engineering and Mathematics (STEM) skills for young people aged between 11 and 19 years. Five different activities are delivered, including one which directly targets females aged 12-16 years to raise awareness of study and career opportunities in this field. An independent evaluation of the project was conducted, with a sample of participants and school representatives consulted individually and in focus groups. The evaluation discovered that female participants and their teachers welcomed female only activities which contributed to challenging stereotypes, resulting in reports of improvement in confidence, and increased awareness of related higher education courses and career routes. Female participants also reported improvement in transferable skills such as communication, teamwork and problem-solving following engagement with project activities. Another achievement for the project included female participants delivering Science and Technology activities and acting as role models for younger females in their school following their engagement with the project.

KEYWORDS

Female, stereotype, careers, engineering, technology, STEM

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INTRODUCTION

The Science, Technology, Engineering and Mathematics (STEM) professions are important to the success and vitality of a nation and its economy. However, even though the number of females working in the STEM sector in the UK is increasing, females are still in the minority in terms of employment rates; making up 24% of the STEM industry's workforce (WISE, 2017). Gender equality is promoted as an overarching priority at all levels of education and throughout women's careers (UNESCO, 2016) and recent reports have highlighted the need to improve STEM education and attract young people into engineering. It is recommended that students need experience of real-life applications of engineering, and 'are well-informed of the many opportunities a career in the profession can provide' (Engineering UK, 2018, p. 14) with gender participation gaps at all levels of education needing to be addressed (National Audit Office, 2018). Equality of gender representation in engineering is of prime concern, with women making up almost 47% of the total workforce in the UK, yet only 20.5% work in the engineering sector (Engineering UK, 2018, p. 170). Diversity and equality within the employment market are also priorities for Welsh Government (Welsh Government, 2015).

This case study presents an overview of activities and evaluation findings of STEM Cymru 2 delivered between 2015 and 2018, which included the aim of increasing the participation of young women in STEM activities and training in Wales. Since 1989 Engineering Education Scheme Wales (EESW) has delivered initiatives to motivate young people in Wales to choose careers in this field. In 2010, the European Social Fund (ESF) funded the organisation to continue to develop and deliver STEM activities for young people. STEM Cymru 2 built on the previous STEM Cymru project (2010-2015), which encouraged young people aged between 11 and 19 years to participate in engineering activities and improve their skills. Equal opportunities and gender mainstreaming are an integral element of ESF funded activities (Welsh European Funding Office, 2018m p. 6). Since the data collection took place ESF funding has been extended to deliver STEM Cymru 2 activities for a further three years, until June 2021.

PROJECT ACTIVITIES

The STEM Cymru 2 project supported the delivery of five different strands. Females participated in all five activities, with one strand - Girls into STEM, delivered solely to females. Both male and female students participated in the other four strands; Introduction to Engineering, which involved practical engineering-based activities; F1 Challenge in Schools - students designed and competed in this international project; Headstart Cymru - 16-17 year old students spent two or three residential days at a university engaged in activities to help them consider technology focused careers; and the EESW Sixth Form Project, which required students to work with employers to solve a practical problem. The Girls into STEM strand included visits to

engineering companies, awareness days and visits to engineering departments in Welsh universities. Challenging stereotypes and misconceptions that engineering is not a career path for females provided a key focus for the activities delivered. Further detail about the STEM Cymru 2 project activities is available ([EESW](#), 2018).

METHOD OF DATA COLLECTION

A mixed-methods approach was adopted for the evaluation. This included a review of contextual documents, for example EESW business plans, as well as feedback data gathered from previous project participants and stakeholders by EESW. A range of interviews, school visits and focus groups were also completed. This involved interviews with members of the STEM Cymru 2 team as well as with Welsh European Funding Office (WEFO) representatives. A sample of schools and colleges, and consultations with students, teachers and school senior leadership team representatives as well as associated employers, universities and other stakeholders contributed to the evaluation.

Due to restricted resources, it was not possible to consult with all participants, so a sample of project activities was selected to ensure all elements of the project were included, as well as geography, participation rates and Welsh language. Fifty Girls into STEM focused activities were delivered by EESW during the course of the project including industry visits and Information Technology workshops. The research team attended five of these, during which 69 female participants were consulted. The research team also attended 21 of the 108 other project activities and consulted with a total of 248 participants (male and female). The influence reported by females during all activities is presented in this case study. In addition, 33 school or college staff, 23 employers and nine university staff were also interviewed during the evaluation of all the STEM Cymru 2 activities.

RESEARCH FINDINGS

Participation targets

To monitor progress against output targets EESW collected indicators of achievement data on a quarterly basis for WEFO. For the duration of the three-year STEM Cymru 2 project the target participation figure for the Girls into STEM activity was 1590. By June 2018 1,364 female students had participated. Across the other four STEM Cymru activities the overall target participation figure for male students was 2,160, whereas 1,240 was the target for female students between 2015 and 2018. It is important to note that when the Girls into STEM target figure is added to the other four activities, the overall female participant target figure is more than that for males, reflecting the commitment of STEM Cymru 2 to support females into STEM.

Having specific participation targets for female students illustrates the importance of positive action to address gender stereotypes, thus contributing to equal opportunities, increasing the proportion of females engaged in the study of STEM subjects and pursuing STEM-based careers. The EESW Sixth Form Project and Headstart Cymru target students engaged in post 16 STEM subjects, and fewer females participate in STEM related subjects at advanced secondary level than males (UNESCO, 2017; WISE, 2015). Between 2015 and June 2018, 3,600 females

had participated across all the different activities, with STEM Cymru 2 well on the way to achieving, and possibly exceeding, the target of 5,704 female participants by 2021.

Influence of activities on female students

Recruitment

Schools reported adopting different approaches to select participants for the Girls into STEM activities. For example, one school offered the opportunity to more able students first, whereas another school invited female students with a range of abilities and backgrounds. As for recruitment for the other STEM Cymru 2 activities; the Introduction to Engineering activities were delivered to a mixture of groups; some schools targeted more able students whereas others offered the opportunity to whole year groups. In most cases the schools and colleges encouraged the more able and talented students to participate in the activities delivered through STEM Cymru 2. This is understandable as the tasks associated with activities were often challenging. For example, students represented their school for the F1 Challenge, which also may explain why more able students were selected to participate. However, some stakeholders raised concerns about the apparent focus on more able students and considered it important to widen access to STEM subjects for all students.

Motivation

Several students participating in the Girls into STEM activities reported they were interested to find out about the topics and looked forward to doing something practical. They also commented that the activities would help them think about possible future study and career options. One female EESW Sixth Form Project participant commented;

"I wanted to take part as it looks good on UCAS forms. I enjoyed working as a group and thinking independently. It's quite cool, it's a real-life project. You have a sense of responsibility, you must produce a solution to a problem. Communication skills are developed, you work independently from the teachers too. We had not thought much about software engineering before, it's a more physical side of IT, it's real."

Some female students who participated in an Information Technology Girls into STEM activity also reported that they thought they would be "stuck in front of a computer", "talked to a lot", "doing stuff like maths" and "it would be boring and all technical". However, female participants commented that the experience was more positive than they had expected. They particularly enjoyed the practical activities such as taking a computer apart. Some female students interviewed also made specific reference to the lack of females within STEM-based study and employment and used this as motivation for their participation. One female student commented; "People say that 'girls don't' and I want to prove a point."

Benefits of participation

Feedback from female students relating to their experiences of the different STEM Cymru 2 activities was positive. For instance, some female students participating in

Girls into STEM noted that they had been able to visit a couple of different engineering settings which meant they were able to compare working environments. Other Girls into STEM participants dismantled a computer, programmed a robot and did some coding. These hands-on practical experiences were valued by the students.

All the STEM Cymru 2 activities contributed to raising awareness of gender equality and challenged gender stereotypes. For instance, one teacher reported that over recent years the uptake by female students for the EESW Sixth Form Project had increased. Another teacher commented that the level of ability of the female students participating in the activities was above that of many of the males, as a result the "boys are upping their game to keep up with them".

Students participating in Girls into STEM activities also reported that they had expected the activities to be "boring" as that is how they perceived STEM. However, participation in the project had challenged this as the activities were "fun" and they had "learnt a lot" in the process. The students interviewed expressed positive views about the activities and wider STEM subjects and this suggests that some girls relate more to STEM and engineering activities when they are delivered specifically to female audiences.

One Girls into STEM participant reported that the "all-girl" sessions were better, as the "boys would be too competitive". Teachers and female students also commented on improvement in confidence and attitude following engagement with the activities;

*"I have noticed the girls we took have grown in confidence in the subject and have put 110% into their work in class."
(Teacher of Girls into STEM participants)*

*"If I were to go into an engineering job now, I would be excited to show – yes I'm a girl and yes I can do it."
(Girls into STEM participant)*

Teachers welcomed the opportunity that participating in STEM Cymru 2 activities offered in relation to raising the aspirations of female students to take up STEM subjects. For several teachers, the timing of the activities i.e. during the years before students make their exam options, provided the opportunity to better inform students, with these teachers reporting an increase in the number of females selecting STEM related subjects as a result.

"The trip seems to have developed their understanding of the subject and their knowledge of the types of careers. They can also see through the female role models they met that it is an industry that is accessible to them and it makes sense to them – they no longer see it as completely alien." (Teacher of Girls into STEM participants)

Females participating in the Headstart Cymru project reported ambitions for engineering; one female student enjoyed visiting the different university departments and the experience confirmed that she wanted to go into aerospace engineering. Another noted that she aspired to be a civil engineer and that the activities confirmed these intentions as well as increasing her awareness of the types of activities encouraging females to study and work in industry.

"The course has confirmed the fact I do want to go into this field."

"It opened my eyes to the possibilities of engineering."

"I didn't know about the different career options before and now I'm aware of the shortage of females in engineering."

(Female STEM Cymru 2 participants)

Overall, female students participating in STEM Cymru 2 activities reported a range of benefits. These included the development of practical skills; improvement in subject knowledge; the development of transferable skills; an understanding of career routes; opportunity to experience university and work on a 'real' problem; and, for some, achieving the CREST Science Award, a scheme for student-led project work in STEM ([CREST Awards](#), 2018). Participation in STEM Cymru 2 activities also contributed to the Welsh Baccalaureate Qualification for some students. This is a qualification for 14 to 19 year olds in Wales, which combines personal development skills with existing qualifications resulting in a wider award ([WJEC](#), 2018).

Teachers also reported on the positive impact of engagement with STEM Cymru 2 on female students' skills such as communication, problem solving, team work and confidence. Communication was reported by students as the key skill they had developed. For example, students taking part in the F1 in Schools Challenge presented their ideas regarding design, gathering sponsorship and the build process at the F1 in Schools Challenge regional events. EESW Sixth Form Project participants presented their solutions to the problem they solved to a panel of assessors and other interested parties during events; and Headstart Cymru participants 'pitched' their ideas to fellow students and university staff. All these examples drew on and supported the development of transferable skills.

Wider benefits

Volunteering is an essential element of the Welsh Baccalaureate Qualification and one teacher working with students engaged in the EESW Sixth Form Project reported on the benefits to their school. An all-female group of participants delivered a Girls into STEM club for 20 females aged 11 to 14 years and four other groups of participants also delivered STEM clubs to 45 students in total. The clubs ran twice a week; 45 minutes at lunchtime and an hour after school. Some students delivering the clubs continued after they had achieved the 30 hours of volunteering required for their Welsh Baccalaureate Qualification. The teaching staff also reported an increase in the number of students, both male and female, undertaking STEM focused individual investigations for their Welsh Baccalaureate Qualification.

CONCLUSIONS

Monitoring data recorded by EESW evidences that participation targets for females were successfully achieved, and with the three-year extension of funding delivering activities until 2021, the female participation figures continue to rise. As reported by teaching staff and female participants, the STEM Cymru 2 activities increased enthusiasm for, and awareness of, the practical application of STEM subjects - particularly engineering - amongst participating females. It is therefore vital that future targets continue to be ambitious to ensure more female students have the opportunity to experience STEM related activities, including receiving related study and career information.

STEM Cymru 2 challenged female stereotypes. Some activities were delivered by female engineers and/or supported by females in similar roles and these positive role models are a key aspect of encouraging more female participation in STEM. Female student participants reported improvement in transferable skills such as communication, team work and problem solving, and that they had developed confidence to pursue further studies and careers in STEM related subjects.

Through a focus on female participants STEM Cymru 2 has addressed one of the more challenging cross-cutting themes required through European Social Fund (ESF) funding, namely equal opportunities and gender mainstreaming. Activities supported by the project have contributed to addressing gender stereotypes and breaking down perceived barriers for females in STEM education and careers.

However, the emphasis some schools placed on focusing on more able students to participate highlights the importance of widening access for all. It is essential that STEM related enrichment activities are available to the wider student population, to ensure improvement in aspirations and awareness for all. It is also important for EESW to continue to prioritise the support of Girls into STEM, using female role models to direct, deliver and support sessions as often as possible.

At a wider project level, some female participants provided role models for younger students by organising and facilitating STEM clubs for girls. Also, participating schools, universities and employers all developed strong partnerships, which have contributed to successful outcomes and this has provided a strong base with which to take the project forward.

To better support similar programme delivery, longitudinal research focusing on the progression of female participants as they make their study and career choices should be considered. In depth qualitative research would also contribute to identify the determining factors that impact on female students' STEM study and career decisions. As a result, future programmes would be able to focus on these factors to enhance young women's academic and career development opportunities within STEM, and provide targeted, relevant activities and timely advice.

ACKNOWLEDGEMENTS

This case study was produced with the full support of the Welsh European Funding Office, who manage the allocation of the European Social Fund in Wales, and

Engineering Education Scheme Wales, who provided the project participation monitoring data. Any opinions, findings, conclusions and recommendations expressed in this account are those of the authors. We would like to thank Bob Cater and Rebecca Davies of EESW for their support.

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