Citation for published version (APA):
IRIS – promoting young people’s participation and attainment in STEM and reigniting teacher’s passion for science education
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The final version of this article was published in Impact – the termly peer reviewed journal of the Chartered College of Teaching and can be found here: https://impact.chartered.college/article/parker-iris-stem-students-teachers-participation-research/

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Abstract
The Institute for Research in Schools (IRIS) provides students and their teachers with the opportunities to participate in authentic STEM research and to make valuable, recognised contributions to the scientific community. To date, students aged 11-18 from over 460 schools, across the UK have participated in a variety of STEM research projects. Our evaluation has analysed quantitative attainment and progress data as well as qualitative information from case studies and questionnaire responses. IRIS has found that this type of research project learning increases the attainment of students, as well as enhancing teacher job satisfaction and retention. IRIS’ work is presented using three case studies of women working with IRIS including, Prof Becky Parker (Director of IRIS and Physics teacher), Ellie Fox (form student of Tapton school, Sheffield, a leading IRIS school) and Dr Lizzie Rushton (Teacher and Head of Evidence and Evaluation, IRIS). This article demonstrates the possibilities to all students and particularly young women, that they are never too young to be a research scientist.

Introduction
Since the launch of The Institute for Research in Schools (IRIS) in March 2016, over 460 schools have registered to join us and by doing so their students and teachers have access to cutting-edge research projects so that they can together experience the excitement and challenge of research science. IRIS achieves this by making data and the necessary experimental equipment available at no charge. We have developed research projects across a variety of areas within STEM including space science, particle physics, material science, biomedical science and climate science.

We suggest that to further develop, expand and enhance STEM education young people must have the opportunity to engage with and make a fundamental contribution to authentic STEM research whilst still at school, and to have that contribution to knowledge recognised and celebrated by the scientific community. Our experiences working with schools show that young people have improved academic and social outcomes and teachers have an increased sense of job satisfaction and professional pride. This paper sets out the vision IRIS has for STEM education and the impact that this on the attainment, progress and wider lives of the young people who participate in research projects. This is presented in the form of three case studies of women working with IRIS including Ellie Fox (former student at Tapton School, Sheffield) and Dr Lizzie Rushton (geography teacher and Head of Evidence and Evaluation, IRIS) and begins with IRIS’ Director, Prof Becky Parker.

Sharing IRIS’ vision for STEM education, Prof Becky Parker
STEM initiatives have often concentrated on bringing the whizz bang into schools to inspire the next generation. IRIS wants to release school students’ potential, so they can help solve some of the challenges the planet faces and in doing so appreciate the opportunities and agency they have in science and engineering. Young people working with IRIS can annotate a human whipworm, put a payload in space, and tackle fundamental challenges of climate change.

IRIS wants students to experience science in a genuine way, mindful of the contributions that young people can have in data analysis and in the analysis of problems. We need to retain science teachers in the profession and make the profession more attractive to scientists. Even with the significant pressures of new exams at GCSE and A level over 460 schools have registered since our launch in March last year and teachers relish the chance to do real science at the cutting edge, so maintaining their passion in the subject. Teachers who are active in IRIS suggest that this model of teaching and research alongside the students should be further developed. An education system where the lines were less rigid between research and school allows sustained collaboration for the benefit of all, especially science itself.

IRIS believes that STEM education should offer opportunities for students to work on genuine problems facing our communities so that young people are part of tackling the challenges of their future. Our Genome Decoders project involves over 1000 students annotating the human whipworm genome working with scientists based at the Wellcome Genome Campus in Cambridge. Teachers and students alike have relished the change to become experts in this particular genome. Their contribution as part of the science community will help address the neglected tropical disease caused by this human whipworm that affects approximately 500 million people globally, mainly children in Asia, Africa and South America.

Students have embraced the opportunity to make a real impact on the lives of their peers yet IRIS itself makes such a significant impact on the lives of students who participate. Ellie Fox is student who participated in early research work in schools.

**Living IRIS’ vision for STEM education, Ellie Fox**

Ellie attended Tapton School between 2008 and 2015 and says that her participation in an Authentic Biology project that used Zebrafish embryos to investigate genes with novel functions in the cardiovascular system was key in shaping her aspirations to study STEM at university. Ellie first went to a project meeting at the beginning of Year 12 (2013) when she saw a poster advertising the research project in school and regularly participated in the research project, attending weekly meetings and participating in experiments. Ellie was part of the team that presented their research at the Wellcome Trust Authentic Biology symposium, contributing to the research poster and presenting the poster at meetings in Sheffield.

Whilst contributing to the Authentic Biology project Ellie developed the ability to analyse results, critical and independent thinking, and research design. Ellie felt that these skills were difficult to develop as part of her A-level studies as in A-level laboratory work ‘there is usually an answer on the mark scheme that your teacher can explain to you’. It was these experiences of research in school that led Ellie to change her degree subject choice to Cellular and Molecular Medicine and having completed the second year of her undergraduate degree she is currently on a year-long research placement with a biochemistry group in the Freie Universitaet, Berlin. This opportunity to work in Germany is the result of a lengthy and difficult application process as few universities offer undergraduate students research placements. Due to her work as part of the zebrafish research project Ellie was able to demonstrate she had experience of techniques including in-situ hybridisation and was able to think critically, analyse results and effectively communicate research findings. This rare opportunity would not have been possible without the school-based authentic Biology research project as at the time of
applying for this placement as a second-year undergraduate, this was her only experience of authentic research. Ellie would wholeheartedly recommend participating in research projects whilst still at school. She believes that such projects enable students to expand and develop their abilities beyond A-level studies and can be a fundamental part of making the successful transition to a career in research science. Participating in research projects is challenging, the subject matter and skills required are demanding and require students to persevere, but if students do persist Ellie believes that they will find the experience exciting and rewarding. Ellie plans to continue with a career in research beyond her undergraduate degree and believes that had she not had the experience of research through Authentic Biology whilst studying at school she would not have the capabilities or confidence to approach research in the way she has as an undergraduate.

Evaluating IRIS’ vision for STEM education, Dr Lizzie Rushton

Although IRIS has only been formally established since March 2016, there have been a small number of schools working on biosciences research since 2013. The Wellcome Trust funded Authentic Biology programme involved sixth form students linked with university departments working on a variety of bioscience projects.

Using attainment data from one of the participating schools IRIS has been able explore the impact of participation in the Authentic Biology programme (AB) on four cohorts of A2 Biology students from 2013-14 to 2016-2017. During the four years of this intervention, 53 A-level Biology students participated and 201 did not and this latter group provided a ‘control group’. Student participation was completely voluntary and was open to any student as there were no academic pre-requisites. Of the 53 participants, 27 were predicted A/A* in A-level Biology, the remaining 26 were predicted B or C grades. The L3VA score was calculated for each student in both the AB group and the ‘control group’ for each year and a mean value calculated.

The L3VA scores stand for ‘Level Three Value Added’ and this is a measure of progress made between the end of KS4 and KS5 as it compares the predicted progress at the end of KS4 with actual progress made at the end of KS5. A value of 1.0 indicates the student has made progress equivalent to a whole grade at A2 level. The use of this measure enables the evaluation of progress rather than simply the attainment of students and this methodology has been used to assess the gap in Science attainment in a review of Science Education completed by Oxford University, commissioned by the Education Endowment Foundation and the Royal Society (2017).

The AB cohorts 2013-2017 achieved an average L3VA of 0.62, compared to the average L3VA of 0.23 achieved by the whole A2 Biology cohort. The average L3VA for A2 Biology students who did not participate in AB was 0.12. This shows that AB students make almost three times the progress of the whole A-level Biology cohort and six times the progress of students who did not participate in AB. As these are students from the same school, taught by the same teachers, it is justifiable to attribute this increase in progress to the AB project. Closer examination of the L3VA measure by each exam grade allows us to explore which students are making the most progress, and the L3VA for students who achieved A/A* grades and C grades in A-level Biology were calculated for groups of students who did participate in Authentic Biology and those students who did not participate.

The average L3VA scores of 0.80 achieved by A/A* grade students from the AB group are broadly similar to the L3VA scores of 0.84 achieved by A/A* students who did not participate in the AB programme. The most substantial difference in L3VA between those who did and did not participate in AB is seen in students who achieved Grade C in A2 Biology.

AB students who achieved a grade C made nearly 10 times the progress of students who did not participate in the programme, with AB students’ average L3VA score 0.59 compared to 0.06 for those who did not participate. Although the number of students who participated in AB and achieved a C grade in this example is small, this measure does provide evidence that this type of learning increases levels of progress and, if the students who did not participate in AB had chosen to do so, many more students may have replicated this level of progress. It is also important to note that this rate of progress within this attainment level could mean the difference between being awarded a place at University and not, enabling more students to access pathways into STEM careers.

Conclusion

Working with teachers in IRIS schools from across the UK suggests that a model where teachers can integrate and include STEM research within their practice is popular for recruitment and retention. This approach also raises the aspirations and attainment of STEM students. In the future, IRIS aims to develop this approach beyond STEM so that teachers actively contribute to research in their chosen area. After all, a music teacher is a professional who combines performance with expert teaching. IRIS provides the opportunities for science teachers and their students to contribute to cutting-edge STEM research as valued members of the science community.