

Institution: Swansea University		
Unit of Assessment: 11		
Title of case study: Technocamps: Transforming Digital Education throughout Wales		
Period when the underpinning research was undertaken: 2000 to 2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s): Faron Moller Stewart Powell Tom Crick	Role(s) (e.g. job title): Professor Tutor Professor	Period(s) employed by submitting HEI: August 2000 – present July 2012 – present February 2018 - present
Period when the claimed impact occurred: August 2013 – December 2020		
Is this case study continued from a case study submitted in 2014? No		
<p>1. Summary of the impact</p> <p>By 2000, it became evident that, in Wales, interest in, knowledge of, and capacity for computing was not keeping pace with the transformational rise of the digital society and economy. Technocamps, the pan-Wales school and community outreach unit established at Swansea University, has researched, championed and delivered change in national curricula, qualifications, delivery and professional development in order to foster a sustainable digital skills pipeline in Wales.</p> <ul style="list-style-type: none"> • Following our 2013 Independent Review of the ICT Curriculum commissioned by the Welsh Government, we led in reforming the subject of ICT and defining and implementing a new statutory bilingual Digital Competence Framework (DCF) for all pupils in Wales aged 3 to 16. • We led on embedding the DCF in schools by delivering 10 hours of workshops in each of 97% of the nation's secondary schools. Since 2016 the DCF has been the primary mechanism of developing cross-curricular digital skills for all pupils in all Welsh schools. • We were instrumental in supporting a major 2018 sector review of ICT qualifications in Wales, and creating innovative GCSE and A-Level qualifications in Digital Technology. • We led the development of the new Science & Technology Area of Learning and Experience in the new Curriculum for Wales, which brings together biology, chemistry, computer science, design & technology, and physics for all learners aged 3 to 16. • We have engaged deeply – our standard programme being 4 full days of activity – with over 45,000 young people since August 2013 (7% of the Welsh population today aged 5-21, with a nearly-even gender balance) to create an interest in the subject, particularly amongst young girls to address a desperately under-represented community in the digital workforce. • We have trained over 100 teachers across Wales who lack a formal ICT/Computing background yet need to teach these subjects due to the shortage of qualified teachers (given that 75% of those teaching ICT/Computing in Wales have no ICT/Computing background). • We led the Institute of Coding in Wales project, part of a wider Office for Students investment in England, impacting on businesses throughout Wales with bespoke innovative CPD opportunities, in particular trailblazer Degree Apprenticeships, giving them competitive edge and saving money; one apprenticeship project will save its company GBP400,000 per year. The impact of this is evidenced by significant changes in Welsh schools, teachers (and thus, teaching practice), pupils, businesses, and in the publication of the new Curriculum for Wales in January 2020, to start from September 2022. 		
<p>2. Underpinning research</p> <p>In 1995, the Department of Computer Science established an industrial liaison unit, ITWales, to facilitate impact of Swansea researchers on the Welsh economy through intervention and engagement. ITWales was highlighted in the EPSRC International Review of ICT in 2006 and is cited in the acknowledgements of research papers published by academics across the Welsh universities. The Founding Director of ITWales, Beti Williams, won Best Woman in Academia and Public Sector category in the Blackberry Woman of the Year Awards 2006, and was appointed MBE in 2012 for pioneering work on small businesses.</p> <p>Through two decades of research, cited and summarised in section 2.3 below and references [R1-R6], we identified a growing need for direct school interventions to address a crisis in computing and digital skills education. This led to the creation of Technocamps in 2003, supported by a sequence of grants, most recently [G1-G6]. Its mission is to provide a wide</p>		

spectrum of activities aimed at identifying and addressing shortcomings in computing education and skills, covering all aspects of: awareness-raising through engagement; curriculum and qualifications reform; policy and practice; and initial teacher education and professional development. More widely, its commitment to computer science education extends to widening participation, providing digital upskilling opportunities to people in employment as well as various opportunities for lifelong learning.

Microsoft was an early supporter of Technocamps, and subsequently created the *Computing at School* (CAS) initiative in England in 2008. CAS is largely run by and for teachers, contrasting Technocamps' direct intervention by, and engagement with, University academics. Whilst the CAS approach is well suited to urban areas with critical masses of schools and capable teachers [R1], **our research indicates that direct intervention is critical** elsewhere – and in particular throughout Wales. Analyses of the impact of each approach reported in [R2, R3] – co-authored by the Director of Technocamps and the Chair of CAS Wales – **evidence the inadequacies of the CAS approach in Wales in contrast to the impact of Technocamps'** direct intervention methodology.

We have explored different models for introducing and embedding competence and confidence in the nation's computing teachers, as well as means to increase the pipeline into the profession amongst computing graduates, reporting these models in various **research publications**: which succeeded and which failed, analysing why, and evidencing impact. In particular, in [R4] we describe the impact of our direct teacher intervention programme and **evidence the need for its methodology**; and in [R5] we reflect on a school placement scheme we introduced which has impacted positively on the participating schools as well as generated a stream of graduates into teacher training. Our efforts in improving education in schools has in return impacted positively on our undergraduate teaching as described in [R6].

3. References to the research

The underpinning research is funded by competitive research grants and reported in papers appearing in rigorously peer reviewed international journals and proceedings.

- R1. Brown, N., Sentence, S., Crick, T., Humphreys, S. (2014) Restart: The resurgence of computer science in UK schools. *ACM Transactions on Computer Science Education* 14:1-22. <https://doi.org/10.1145/2602484>.
- R2. Crick, T., Moller, F. (2015) Technocamps: Advancing Computer Science Education in Wales. *WiPSCE'15: Primary and Secondary Computing Education*, p121–126, ACM Press. <https://doi.org/10.1145/2818314.2818341>.
- R3. Moller, F., Crick, T. (2018) A university-based model for supporting computer science curriculum reform. *Journal of Computers in Education* 5:415-434, 2018. <https://doi.org/10.1007/s40692-018-0117-x>.
- R4. Moller, F., Powell, S. (2019) Technoteach: Supporting computing teachers across Wales. *WiPSCE'19: the 14th Workshop in Primary and Secondary Computing Education*, Article 9:1-2, ACM Press. <https://doi.org/10.1145/3361721.3361736>.
- R5. Moller, F., Powell, S. (2019) Teaching computing via a school placement. *CEP'19: Computing Education Practice*, Article 3:1-4, ACM Press. <https://doi.org/10.1145/3294016.3294029>.
- R6. Moller, F., O'Reilly, L. (2019) On teaching discrete mathematics to freshman computer science students. *Journal of Higher Education Theory and Practice* 19:25-38. <https://doi.org/10.33423/jhetp.v19i8.2670>.

Grants

- G1. Moller, F. (PI) (06.2018-08.2022). WEFO grant *Technocamps 2*, **GBP5,300,000**
- G2. Moller, F. (PI) (09.2014-09.2016). DfES grant *Learning in Digital Wales*, **GBP450,000**
- G3. Moller, F. (PI) (04.2016-03.2018). DfES grant *Technocamps – Mobilisation*, **GBP600,000**
- G4. Moller, F. (PI) (04.2018-08.2022). DfES grant *Technocamps – Enhancing STEM Attainment*, **GBP1,200,000**
- G5. Moller, F. (PI) (03.2018-09.2022). HEFCW grant *Institute of Coding in Wales*, **GBP1,200,000**
- G6. Moller, F. (PI) (09.2018-08.2023). HEFCW grant *Degree Apprenticeship programme*, **GBP4,200,000**

4. Details of the impact

From researching the relevant issues since 2000, and by establishing Technocamps in 2003 as a formal unit in which to do so, our influence and impact has been steadily growing – within government, and on schools, school children and teachers across the nation – in: advocating for a need for curriculum reform; stimulating a demand for these; producing the defining reports on these; introducing these within the nation's schools; and providing much-needed professional development for teachers to deliver them, in Welsh and English. Our main impact since August 2013 has been in three areas:

1. The creation and embedding of a new national **Digital Competence Framework**.
2. **Curriculum reform** leading to the transformation of ICT education, and the development of a new Science & Technology Area of Learning and Experience.
3. The creation of **new GCSE and A-level qualifications in Digital Technology**.

4.1 The Digital Competence Framework

In his Keynote Speech at the 2012 Technocamps Annual Conference, the Minister for Education and Skills for Wales created an environment for impact for Technocamps by declaring that:

“Technocamps is an important driver in making sure learners in Wales are best placed to take advantage of opportunities [in the expanding digital workforce]. I would encourage headteachers to ensure that their school is engaged with Technocamps.” [C1]

He also announced the creation of the digital learning platform, *Hwb*, supported by a *National Digital Literacy Council*, with Moller and Crick as expert advisors; and subsequently commissioned a subject review co-chaired by Crick with Moller as a panel member. The September 2013 ICT Review Report published by this panel proposed the introduction of a **Digital Competence Framework** (DCF) to sit alongside the existing *Numeracy and Literacy Frameworks*. This proposal was picked up and included as a recommendation in “*Successful Futures: Independent Review of Curriculum and Assessment Arrangements in Wales*” (March 2015). According to the author of this work:

“The ICT review was influential in my curriculum review in two ways: I adopted its recommendation for increasing the prominence of cross-curricular digital skills, resulting in the DCF; and it fed into my thinking in embedding computer science into the Science and Technology AoLE.” [C2]

This recommendation was immediately adopted by Welsh Government, and Crick led digital pioneer teachers in developing its content. According to the Welsh Government Minister of Education,

“The Digital Competence Framework owes much to Professor Crick’s leadership. He took a leading role in defining the DCF, chairing its development to publication for all schools in Wales in September 2016.” [C3]

The DCF was introduced in a phased fashion into schools starting in September 2018, to be fully integrated in all schools at all levels from September 2021, with an effort led by Technocamps. In 2018, Technocamps was commissioned by the Minister of Education to facilitate the introduction of the DCF in schools with a project to deliver 3-hour workshops in secondary schools. This was in recognition of the impact of Technocamps’ direct intervention model (see [R4-R5] above). By the end of the 18-month project, due to numerous requests for return visits, we averaged over 10 hours of workshops in each of more than 97% of the nation’s secondary schools. The impact of this intervention is evidenced by letters from schools, the following quote from a school head being indicative:

“Technocamps played an essential role in the introduction and implementation of the DCF within our school. The support provided was invaluable and provided a springboard to ensure an effective take-up throughout the school.” [C4]

4.2 The Future of Science & Technology Education in Wales

As part of the wider Curriculum for Wales reforms as outlined in “*Successful Futures*” (2015), Crick was invited to **lead the future vision of Science & Technology education**, by chairing one of

the six new *Areas of Learning and Experience* (AoLE). The Science & Technology AoLE brings together the disciplines of biology, chemistry, computer science, design & technology, and physics for all learners in Wales aged 3 to 16. This was a radical innovation from the current national curriculum in Wales, providing the opportunity for interdisciplinary cross-curricular learning, as well as the first time that computer science was recognised as a core subject. As part of these reforms, Crick was also appointed in 2017 to **chair the National Network for Excellence in Science & Technology (NNEST)**, with Moller as a board member, a £4M strategic investment by the Welsh Government to support the professional development of teachers in this key area of the new *Curriculum for Wales*. The NNEST has demonstrably improved confidence and capability for STEM practitioners in Wales, with major research-led policy and practice initiatives across primary and secondary-level settings, in partnership with all HE institutions in Wales. It has also directly contributed to the development of a new national strategy for educational research and enquiry in Wales. According to the Welsh Government Minister of Education:

“Professor Crick has played a leading role working on the Science and Technology AoLE, as well as being inaugural chair of the National Network of Excellence in Science and Technology (NNEST), both of which included Professor Moller as an expert advisor. I have been clear on the importance of higher education's wider civic mission agenda and specifically the body of knowledge and activities which Technocamps represents as a pan-Wales organisation involving all of the nation's higher education institutions.” [C3]

4.3 New Qualifications in Digital Technology

In 2012, the Minister of Education in England declared that ICT education was not fit for purpose and that ICT qualifications (GCSE and A-level) would be removed, leaving computer science as the only digital qualification. In response, *Qualifications Wales* (QW) – the body created in 2015 to regulate all qualifications in Wales below HE level – established a working group to consider the future of ICT in Wales. As members of this group, we were vocal in recognising ICT as a worthy qualification distinct from computer science. However, we also saw scope for wholly new qualifications which would address the *use* of digital technology, and we proposed that QW develop thinking towards the creation of **new GCSE and A-level qualifications in Digital Technology**.

We worked with QW in developing these ideas and hosted the launch of their **Review of ICT Provision Report, “Delivering Digital”** (December 2018), which announced the introduction of these new qualifications. We have subsequently been sitting on their Advisory Group developing the frameworks for these qualifications; and we are working on the **development of the GCSE curriculum, and on teaching and learning resources** to provide the professional development that will be much needed by the teachers that will be delivering this from September 2021. Our impact in driving this change is acknowledged by the Director of QW:

“Qualifications Wales is grateful for the advice and support that Technocamps has provided. We are benefitting from this, in defining the new curriculum and in making it a reality. Due to their national recognition and reach, we very much view Technocamps as a one-stop shop for expertise, knowledge, and implementation of computing and digital education for Wales.” [C5]

4.4 Wider Impact

Besides the profound impact on education that we have had through the DCF and curriculum reform, Technocamps has had further impact across a wide spectrum of stakeholders and beneficiaries (see [C9] for general testimonials).

- **We impact teachers** by providing professional development opportunities (see research references [R4,R5] above) to enable them to deliver the new computing curriculum and qualifications – particularly necessary given that only 25% of the nation's Computing/ICT teachers have a relevant background. Since 2015, we have been providing a programme of study requiring teachers to spend one day per fortnight on Swansea University campus throughout the year. In the first year, **13 teachers** completed the programme; and in the second year, a further **17 teachers** did so. The popularity of the programme has grown due to its impact on participating schools, to the point where in 2018, **43 teachers** graduated from the course. This programme is directly impacting on substantial numbers of young people, as evidenced in various case studies. For example, one Assistant Headteacher in a remote

school, having undertaken our teacher training programme, introduced GCSE Computing in her school for a healthy-sized cohort, resulting in 84% scoring A* to C (with 26% scoring A*) against a national average of 49% A*- C. In her support letter, she writes:

"This excellent result would not have been possible without Technocamps support." [C6]

- **We impact young people** by enlightening them on the wider benefits of studying computer science and related STEM subjects at GCSE and A-level and beyond. Since August 2013, we have engaged with 45,000 young people – 7% of the Welsh population today aged 5-24 – with a nearly even gender balance. There has been a dramatic year-on-year increase in the number of first-year computer science students at Swansea: from 150 starting in October 2015, to 250 starting in October 2016, to 350 starting in October 2017 (despite the entry requirements being made slightly more stringent). Whilst there are various factors for this, Technocamps has had a demonstrable influence on this trend: potential students and their parents regularly acknowledge Technocamps during University Visit Days as a brand they recognise and of which they have had a positive experience. Furthermore, the work of Technocamps ensures that this growing pipeline is not only greater but populated by students who have a deeper understanding and appreciation of the subject. **(Data available in [C8].)**
- **We impact businesses** through the **Institute of Coding (IoC) in Wales**. In 2018, the Prime Minister Theresa May announced the establishment of the National *Institute of Coding (IoC)*, a three-year, GBP20,000,000 academic think tank representing a collaboration of 20 universities aimed at widening participation and expanding the pipeline of students into computer science education. As a HEFCE-funded initiative, only universities in England benefit (financially) from this initiative. However, due to the recognition of the work of Technocamps in Wales, Swansea University was included in the tender to HEFCE. Once it was launched, HEFCW provided support for the *IoC in Wales* under Professor Moller's Directorship through a GBP1,200,000 grant to Swansea University. This has facilitated our successful **Degree Apprenticeship** programme, and in 2019 we produced the first cohort of Degree Apprenticeship Graduates in Wales, with many strong case studies being provided. According to the Director of EPS Construction, the final-year software project that their apprentice carried out reaped unexpectedly great benefits:
"This software will save EPS £400,000 per year, already saving £70,000 on one of our completed trial job." [C7]
- **We impact Swansea University**, through (i) driving the establishment of *CoSMOS: the College of Science Margam Outreach Space* in 2019, a unique facility embodying and underpinning the University's civic mission agenda; (ii) providing positive reform to the pedagogic underpinning of the undergraduate programme as described above (research reference [R6] above); and (iii) through the establishment in 2018 of a cross-disciplinary research group *EHP: Educational, Historical and Philosophical Foundations of Computer Science* as the research arm of Technocamps.
- **We impact the UK University Leadership**, through the establishment of an *Outreach Committee of CPHC: the Council of Professors and Heads of Computing*. Technocamps Swansea was to host the first meeting held by this committee in April 2020, though the Covid-19 pandemic forced its cancellation. An aim of this Committee, with membership from all four nations of the UK, is to determine how to transfer the successful university-based model of Technocamps in Wales (research reference [R3] above) to the three other nations.

5. Sources to corroborate the impact

- [C1]. Public Speech by Minister for Education and Skills (2009-2013).
- [C2]. Letter from author of "*Successful Futures*".
- [C3]. Letter from Minister for Education (2016-2021).
- [C4]. Letter from Curriculum Leader at Cardiff High School.
- [C5]. Letter from Qualifications Wales Director.
- [C6]. Letter from Assistant Head at Sir Thomas Picton School, Haverfordwest.
- [C7]. Letter from EPS Director.
- [C8]. The data underpinning the work and research is available from the Technocamps Data Repository (TDR): (Under embargo due to DPA/GDPR.)
- [C9]. <https://www.technocamps.com/en/testimonials/>