Submission to Informatics Europe

2022 Best Practices in Education Award

Educating the Workforce for the Digital Transformation

This nomination is being made on behalf of the following organisation:

Technocamps

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Synopsis

Technocamps is a national universities STEM outreach programme founded and based at Swansea University and with a hub in the computer science department of every university in Wales. It offers programmes for engaging with primary schools, secondary schools, teachers, school leavers, adult learners, and businesses. As a universities-based programme, it is underpinned by a multidisciplinary research group, and maintains a Steering Group and an Industrial Advisory Group. Its director is an Expert Advisor to Welsh Government, and has been a leading voice in developing government policy for providing and nurturing digital skill education pathways, which has been supported and delivered by Technocamps for over 20 years.

Description of the achievements (max 5 pages)

Summary of Achievements

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*, a 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.

- Following its **2013 Independent Review of the ICT Curriculum** commissioned by the Welsh Government[1], Technocamps 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.

- Technocamps led on **embedding the DCF in schools** by delivering over 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**.

- Technocamps was instrumental in supporting a major 2018 sector review of ICT qualifications in Wales, in launching its Review[2], and in **creating innovative GCSE and A-Level qualifications in** *Digital Technology*.

- Technocamps led the **development** of the new **Science & Technology Area of Learning and Experience** in the new *Curriculum for Wales*[3], which brings together biology, chemistry, computer science, design & technology, and physics for all learners aged 3 to 16.

- Technocamps has engaged deeply – its standard programme being 4 full days of activity – with over **65,000 young people** since 2011 (representing 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.

- Technocamps has trained to accredited award level over **100 teachers** across Wales who lack a formal ICT/Computing background yet teach these subjects

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[1] *The ICT Steering Group's Report to the Welsh Government*, September 2013. https://gov.wales/-sites/default/files/publications/2018-11/the-ict-steering-group-s-report-to-the-welsh-government.pdf

[2] *Delivering Digital: Sector Review of Qualifications and the Qualifications System in Information and Communication Technology*, December 2018. https://www.qualificationswales.org/english/publications/-delivering-digital-review-of-qualifications-in-the-ict-sector-2018/

[3] *Successful Futures: Independent Review of Curriculum and Assessment Arrangements in Wales*, February 2015. https://gov.wales/successful-futures-review-curriculum-and-assessment-arrangements

due to the shortage of qualified teachers, given that 75% of those teaching ICT/Computing in Wales have no ICT/Computing background.

- Technocamps' business-focussed *Institute of Coding in Wales* programme **impacts on businesses** throughout Wales with bespoke innovative, fully-funded CPD opportunities, in particular trailblazer Degree Apprenticeships and micro-credentials, giving them competitive edge and saving money, with one apprenticeship project **saving its company £400,000 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**[4] in January 2020.

Background to Technocamps

In 1995, the Department of Computer Science at Swansea University 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 UK Engineering and Physical Sciences Research Council 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.

Through two decades of research, cited and summarised below and in references [**R1-R6**] listed below, a growing **need for direct school interventions** to address a crisis in computing and digital skills education was indentified. This **led to the creation of Technocamps** in 2003, supported by a sequence of grants, most recently [**G1-G6**] listed below. Its mission is to provide a wide 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.

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[4] https://hwb.gov.wales/curriculum-for-wales

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, providing £25,000 for a week-long series of regional workshops in 2003, and subsequently created the *Computing at School* (CAS) initiative in England in 2008. Technocamps is a staunch supporter of the CAS initiative; indeed, a member of the Technocamps team in Swansea, Professor Tom Crick, is the Chair of CAS Wales. However, CAS is largely run by and for teachers – as reflected in its motto *"There's no them, there's only us"* – 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**], **its research indicates that direct intervention is critical** elsewhere – and in particular throughout Wales, which has 3 million people spread out across a rugged geography with few fast roads. Welsh secondary schools have an average catchment area of 100 square kilometres. Schools – and their teachers – are isolated, in terms of geography and, thus, subject support. 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.

Technocamps has 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, [**R4**] describes the impact of Technocamps' direct teacher intervention programme and **evidences the need for its methodology**; and [**R5**] reflects on a school placement scheme which has impacted positively on the participating schools as well as generated a new pipeline of graduates into teacher training. Technocamps' efforts in improving education in schools has in return impacted positively on its undergraduate teaching as described in [**R6**].

Selected Research Publications

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.

Selected Funding Grants

Evidence of availability of the outcomes of the initiative to the teaching community (max 2 pages)

As is evidenced throughout this submission, Technocamps impacts heavily on the teaching community. This section, outlines a few of its past year's activities to provide examples of concrete teacher support.

It needs to be noted that all of Technocamps' activities are provided at no cost to the participants, be they pupils, teachers, adult learners, businesses, or apprentices; and all of its resources are freely available from its website.

Technocamps had a busy year providing training to hundreds of teachers to help them achieve excellence in their pursuit to teach computing and digital technology. It offered CPD and training opportunities to both primary and secondary school teachers, with specific events and programmes suited to their needs.

Minecraft for Education

Minecraft Education Edition is an educational version of Minecraft specifically designed for classroom use. This year, Technocamps worked with schools across the country to design hospices, train stations, co-housing projects and parks using the software. Participants gained an additional understanding of sustainability, accessibility, residential and political requirements while designing their ideas which, in some cases, will be used to influence local council planning departments.

Home-school support

During the COVID-19 pandemic, Techncoamps provided 4,000 physical STEM activity workbooks and resources to support home-schooling without the need for internet access (which is notoriously unreliable in some parts of rural Wales). It worked across its hubs in Welsh Universities to provide digital resources, activities and workshops for schoolchildren in Wales throughout the pandemic. Following feedback that not all children have easy access to these resources, it posted 4,000 bilingual activity packs to secondary schoolchildren across Wales to work on in their own time, requiring little or no support from parents or teachers. With school closures and disruption, evidence showed that children, particularly those from disadvantaged backgrounds, were falling behind with their schoolwork. So, Technocamps created physical resources to help pupils keep learning.

Digital Technology GCSE

The new Digital Technology GCSE in Wales is a broad church digital-based qualification which provides learners with an insight into the use and understanding of technology as part of their social and professional lives. As a new and wholly

innovative qualification, the demand from teachers for help in preparing for and then delivering this in the classroom has been substantial. This past year, Technocamps offered a free training programme designed to support secondary school teachers with the delivery of the Digital Technology GCSE in Wales, including sessions on Cyber Security, Media Development and Data Analysis. Over 240 teachers across the country benefitted from this help.

Annual Teachers Conference

Technocamps' annual Education Conference welcomed over 200 attendees and covered aspects of the new Digital Technology GCSE in Wales, the advantages of Minecraft for Education, networking opportunities for teachers and more. It was a welcome return to physical gathering and networking after two years of being forced on-line due to COVID-19 restrictions.

Evidence of impact (max 5 pages)

From researching the relevant issues since 2000, and by establishing Technocamps in 2003 as a formal unit in which to do so, its 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. Technocamps' main recent impact 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**.

1. The Digital Competence Framework

In his Keynote Speech at the 2012 Technocamps Annual Teachers 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 the Director of Technocamps Faron Moller named as an expert advisor; and subsequently commissioned a subject review 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 national *Numeracy and Literacy Frameworks*. This proposal was picked up by Professor Graham Donaldson and included as a recommendation in *"Successful Futures: Independent Review of Curriculum and Assessment Arrangements in Wales"* (February 2015). According to Professor Donaldson:

> *"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 Digital Competence Framework; and it fed into my thinking in embedding computer science into the Science and Technology Area of Learning and Experience."* [**C2**]

This recommendation was immediately adopted by Welsh Government, and Technocamps 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, Technocamps 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**]

2.   The Future of Science & Technology Education in Wales

As part of the wider Curriculum for Wales reforms as outlined in "Successful Futures" (2015), Technocamps 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, Moller was appointed in 2017 to the Board of the **National Network for Excellence in Science & Technology (NNEST)**, with Crick as its Chair. This was 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**]

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 in schools (GCSE and A-level) would be removed, leaving computer science as the only digital qualification. Reacting to this, *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, Technocamps was vocal in recognising ICT as a worthy qualification distinct from computer science. However, it also saw scope for wholly new qualifications which would address the *use* of digital technology, and Technocamps proposed that QW develop thinking towards the creation of **new GCSE and A-level qualifications in** *Digital Technology*.

Technocamps 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. It has subsequently been sitting on their Advisory Group developing the frameworks for these qualifications; and is 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. Technocamps' 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. Wider Impact

Besides the profound impact on education that it has 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).

- **Technocamps impacts 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, Technocamps has been providing a programme of study requiring teachers to spend one day per fortnight at the 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 the 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**]

- **Technocamps impacts 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 2011, Technocamps has engaged with 65,000 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**]**.)**

- **Technocamps impacts 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, £20M academic think tank representing a collaboration of 20 universities aimed at widening participation and expanding the pipeline of students into computer science education. As an English Government 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 the English Government. Once it was launched, the Welsh Government provided support for the *IoC in Wales* under Professor Moller's Directorship through a £1.2M grant. This has facilitated its successful **Degree Apprenticeship** programme, and in 2019 Technocamps 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 jobs."* [**C7**]

- **Technocamps impacts 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.

- **Technocamps impacts 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.

References and Letters of Support

The letters [C2-C7] in the following list of cited references are provided as an addendum to this submission. These letters were, for the most part, provided in support of an impact case study for Technocamps, and as such provide the relevant support for the present submission.

[C1]. Public Speech by Leighton Andrews, Minister for Education and Skills (2009-2013).

[C2]. Letter from Professor Graham Donaldson CB, author of "*Successful Futures*".

[C3]. Letter from Kirsty Williams MS, 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]. Testimonials available at https://www.technocamps.com/en/testimonials/