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Multination Research Programmes: The UNESCO UNITWIN in Humanitarian Engineering Outreach Case Study

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Abstract

This paper describes the building of partnerships involving multiple nations through the United Nations Education, Scientific and Cultural Organisation's university twinning and networking scheme (UNESCO UNITWIN) in Humanitarian Engineering. The originators of the UNESCO UNITWIN span the globe: the network's coordinator is Coventy University, based in the UK, and is supported by the Institute of Accountancy Arusha, Tanzania; the University of Malta and Massey University in New Zealand.

The main objectives of the UNESCO UNITWIN is to promote an integrated system of research, training and information on humanitarian engineering and to enhance cross-cultural learning and sharing. We believe that humanitarian engineering is about having a forward thinking view: investing in what adds value to society, looking at how to use our engineering capability to apply technology appropriately into communites' self-identified needs.

This paper reviews how the UNESCO UNITWIN was formed and describes a case study of an outreach programme; addressing one of the network's goals to raise public awareness about how engineering can help society. Using these two 'lenses' we highlight the challenges of partnering with multiple nations using documented theories of transdisciplinary working. Challenges such as inexperience and communicating over large time-zone differences replicates what other transdisciplinary programmes experience. What we have learnt is that knowledge about multination collaboration is tacit. The challenge for the engineering education community is to make this knowledge explict so that we can equip ourselves and the next generation of engineers to effectively practice across disciplines and cultures.

Introduction and Rationale

Currently, engineering education globally is going through a tough time. Firstly there is a shortage of young people wishing to embark on an engineering career. The Royal Academy of Engineering[1] reports that the UK will require "1.28m new science, engineering and technology professionals and technicians by 2020." In Australia, a Senate inquiry[2] was set up to address the shortage of engineering and related employment skills. The American Immigration Council[3] are calling for new policies to improve Science, Technology, Engineering and Mathematics (STEM) training throughout the U.S. educational system in the interest of their economy's recovery. To compound this problem current engineering education programmes may be regarded as too abstract, out of touch, hard work and boring that focus on theoretical foundation rather than student-centred practice[4]. In addition there is an under representation of females practicing engineering where (in countries such as the UK and Australia) women bearly reach 10% of the profession's cohort[5,6].

There are many initatives government, educational and industry sectors are implementing to address these issues, e.g. developing curricula that is more aligned for the challenges students will face in their working career (such as the Conceive-Design-Implement-Operate movement[7]) and the resurgence of apprenticeships[8]. A suggestion, in UNESCO's commissioned landmark report[4] on transforming engineering education purports that the:

"promotion of public and policy understanding and interest in engineering, will happen with the better appreciation of the vital contribution of engineering to development, sustainability and poverty reduction…….activities such as "Engineers Without Borders" …..are attractive to students…. Such initiatives help enrolment, public awareness and policy implementation of the importance of engineering in social, economic, international and humanitarian development."

We believe that by being very explicit about connecting engineering with its benefits to society it will help address both the gender disparity and increase general interest (irrespective of gender) in engineering. This is one of the reasons why a key objective of our UNESCO UNITWIN programme is developing effective outreach programmes that relate to humanitarian engineering.

If we analyse the definition of the humanitarian engineer[9] "the artful drawing on science to direct the resources of nature with active compassion to meet the basic needs of all – especially the economically poor, or otherwise marginalized" it forces engineers to embrace their social, cultural and ethical skills. Skills that may be underdeveloped, in many practicing engineers, due to their education and professional experience. This leads to a call to converge concepts, disciplines, and epistemologies to solve complex problems that are bound by larger social systems and its interdependencies, i.e. leading engineers to work with various disciplines from agriculture, medicine, earth sciences, social sciences and education[9]. This transdisciplinary sytems approach also supports the thrust of the UNESCO UNITWIN programme to support projects that are interdisciplinary and intersectoral. This scheme, established as a result of a UNESCO resolution adopted in 1991, serves as a prime means of building the capacities of higher education and research institutions through the exchange of knowledge and sharing, in a spirit of international solidarity.

It is appreciated that UNESCO sanctioned the formation of the UNITWIN network in Humanitarian Engineering. The UNESCO UNITWIN has purposely sought to provide a transdisciplinary network through its founders. We have a convergence of humanities and international relations (through the University of Malta), business and economics (through the Institute of Accountancy Arusha, Tanzania), engineering education (through Massey University, New Zealand) and humanitarian engineering (through Coventry University, UK). Through its international platform, the purpose is to examine key areas where engineering can be harnessed to improve humanitarian and development outcomes. These areas are to: develop resource materials that are appropriate, culturally-relevant, that promote effective practice; deliver an international postgraduate course specifically in the area of humanitarian engineering; develop outreach programmes at all levels that encompasses pre-school through to industrial professional development.

This paper describes the initial process of the UNESCO UNITWIN's formation followed by a description of how two of the collaborators have operated during the development of one of its objectives i.e. the development of outreach programmes. We shall use Stokols et al. working model[13] of transdisciplinary scientific collaboration to benchmark our collaborative effort. This model is favoured as it has been extensively cited[14]. We will also reflect on our ability to collaborate between a disparate body of researchers as we wish to add to the debate on international collaborations; particularly as transdisciplinary networks, that span major geographic and cultural boundaries, are extremely complex[10]. As general literature points to a number of factors that inhibit the development of successful collaborations such as expertise,

language, cultural values, belief and norms, management, time and resources, age/seniority, negotiation style, trust, personal connection[10,11,12].

UNESCO UNITWIN Formation

The UNESCO UNITWIN in Humanitarian Engineering was signed in May 2013. Two years of the initiative have transpired and the first report has not yet been submitted to UNESCO, therefore the data summarised in this paper should be treated very much as preliminary data and interpreted as such.

When initially setting up the UNESCO UNITWIN strong parallels could be drawn between its operation and the Tuckman Model for 'Developmental Sequence in Small Groups'[15]. With the actual development and writing of the proposal simulating the Forming Stage cultivating a positive and polite atmosphere between partners. This has rapidly been followed by the Storming Stage of Tuckman's Model where members start to push at boundaries and look for their positions and roles to be clarified. These challenges are magnified when looking to work in a multination transdisciplinary project such as the UNESCO UNITWIN.

In their paper designed to evaluate transdisciplinary science, Stokols et al. presented a conceptual framework[13] that took three 'antecedent conditions' (i.e. personal, physical and bureaucratic and structural issues), reviewed the 'processes' that these antecedent conditions produced and the resultant 'outcomes' that influence the prospects for a successful transdisciplinary project. This was then strengthened by the work of Morgan et al. who, after reviewing data provided by several transdisciplinary centres, identified several overarching themes that presented challenges in this type of global cross cutting work[16]. When examined in detail it can be said that these overarching themes present themselves as 'processes' in Stokol's conceptual model allowing for the development of an 'outcome' to improve the operation of the transdisciplinary project. This is summarised in Table 1.

Table 1. Adaptation of Stokols et al. Model of Transdisciplinary Scientific Collaboration[13]

Antecedent	Overarching Theme (Process) – *Brief explanation*	Example 'Outcomes'
Bureaucratic & Structural	1. Universities inexperience with transdisciplinary work – *Universities are rarely prepared to make transdisciplinary collaborations run smoothly*	Group Coaching, pre project team training, clarification of project mission
Personal, Physical	2. Opportunities for face-to-face interaction – *spatially distant locations limit face to face interaction*	Structured communication strategy
Bureaucratic & Structural	3. Tenure and merit review procedures – *few universities offer incentives to encourage transdisciplinary collaborations*	Incentives to engage with the process
Personal	4. Departmental chauvinism and disciplinary disrespect – *debates and tensions surrounding social science versus technical science*	Structured training programmes
Personal, Physical	5. Collaborative successes and progress towards intellectual integration – *can progress towards innovative work bridging multiple fields be demonstrated*	Publications
Personal, Physical	6. Critical experiences and 'milestone' events in the development of effective collaboration – *certain meetings have been identified as playing a pivotal role in simulating transdisciplinary collaboration*	Structured communication strategy
Bureaucratic & Structural, Personal	7. Readiness to collaborate – *an initial lack of readiness of some partners to collaborate*	Group Coaching, pre project team training
Bureaucratic & Structural	8. Support for working models and conceptual themes – *joint efforts to link concepts and methods drawn from two or more fields*	Structured training programmes

Over the preliminary 18 months of operation of the UNESCO UNITWIN several generic challenges have been identified which can be mapped against the Table 1 and seen to be a 'process' resulting from an antecedent condition. By using both Stokols et al's and Morgan et al's models[13,16], constructive 'Outcomes' have been developed to support the progress of the UNITWIN. Tables 2, 3 and 4 summarise the challenges resulting from or a lack of an antecedent condition.

Table 2. Antecedent Condition – Personal

Highlighted Challenge	Themes
Differing understandings of the term 'coordination' some cultures interpreted this as 'organisation' and 'instruction of activities' – compounded by lack of direction from UNESCO	1, 2, 7
Lack of knowledge of each other's strengths and areas of expertise, what each partner brought to the table and what each partner wanted from the Network	1, 2 4, 7
Some partners already had longstanding working relationships or deep understanding of each other's cultural differences that resulted in them moving their Networks forward faster than the newer members	7, 8
Cultural issues – 4 very different universities – which was at the start perceived as a strength – but in operation can also act as a weakness as each has very different humanitarian problems that they wish to address as highlighted by the Outreach Case Study	1, 4, 5, 7

Table 3. Antecedent Condition – Physical Environment

Highlighted Challenge	Themes
It was always known that the time difference between countries would be a challenge but this has proved more difficult than initially anticipated	1,2,5,6,7,8
Incompatible online video conferencing technologies made it difficult to conduct virtual face-to-face meetings and webinars critical for collaborative working practices over geographically separate locations	1,2,7

Table 4. Antecedent Condition - Bureaucratic and Structural Issues

Highlighted Challenge	Themes
The initial paperwork required by UNESCO required each Head of University (Vice Chancellor / Rector) to sign in person and due to a lack of logistical reliability across countries on one occasion the paper work went missing.	1, 7
Changes in internal structuring with in some of the partner organisations. One organisation of the UNESCO UNITWIN has resided in 3 different departments in its 2 years of operation, none of which have the same operational procedures.	1
Changes in key personnel or personnel's working hours resulting in no clear key point of contact as many of the initial negotiations took place at a very senior level and these are not the members of staff delivering the outputs for the partnership.	1
Each partner has different modes of operation for term times, teaching loads and other duties of staff external to the UNITWIN. This means it is difficult to get a time that all partners are able to dedicate time to the project.	1,5
Some partners have no financial targets in their Institutional Research Targets and have active strands that specify deliverables in Multi-Disciplinary Research where as other partner academics were under pressure to use the Network to generate income and had targets in the areas of Internationalisation, Student Satisfaction and Curriculum Development.	1, 3, 5, 7, 8

As a result of analysing these challenges the following Outcomes have been proposed and are in the process of being implemented to enhance the operation of the UNITWIN:

- Development of a 'New Partners agreement' for new institutions joining the UNITWIN. This will incorporate a method of recording clear expectations on both sides, reporting methods and timings.
- Better planning of subject specific meetings with exact regularity under negotiation.

- Development of potential retreats and workshops (some on line some linked to conferences or academic exchange programmes)
- Expansion of the use and population of the website.
- Requirement of every partner to have a minimum of a single dedicated link member of staff with encouragement of this to be an early career academic to challenge Stokol's observations that junior members of staff are reluctant to engage with transdisciplinary initiatives.
- Calendar and map to be added to website to record term times, key meetings, geographical locations and time differences of partners.
- Technology policy developed to give to new partners of what technology is ideal and how to engage if that technology is not available.

Case Study: Outreach Programme in Humanitarian Engineering

We strongly support the suggestion made by Beanland & Hadgraft that by demonstrating the social benefits of engineering to young people (girls and boys) it will raise their aspirations to pursue a career in engineering[4]. This linkage of engineering to social benefit is also highly pertinent to girls and women. Research[17] shows women are more inclined to study subjects they find 'socially relevant', and more likely to be motivated by the idea (to study engineering) that they would 'make a difference'[18]. Due to the potential that humanitarian engineering can raise the aspirations of young people to pursue a career in engineering, one of the key objectives of the UNESCO UNITWIN is to develop outreach programmes that can be disseminated internationally.
During 2014 the UNESCO UNITWIN's Coordinator, Liz Miles at Coventry University, specifically asked each of the parties to determine a work plan of cooperation during the four years of the programme. During this phase there were face-to-face meetings to discuss each parties' priorities with regards to contributing to the objectives of the UNESCO UNITWIN. The result of this phase is that Coventry University (UK) and Massey University (NZ) decided to intially focus on the outreach objective. As the Institute of Accounting in Arusha has no engineering provision it was decided that they would focus initially on engagement with the Academic and Student Exchange strand of the programme and as Malta University is the only University on the Island they chose to observe this initial phase of dissemination and are in discussions as to the use of the outreach work specifically to address gender balance in their engineering programmes. Using Stokols et al. model[13] the following discusses the collaboration of these two partners, and describes the antecedents that were present and questions if these built strong or weak processes that are conducive for positive outcomes.

Antecedent Conditions – Personal Environment

Stokols et al. identify that personal factors such as values, expectations, goals and experience have an affect on transdiciplinary collaboration[13]. The key people leading the outreach programmes are Liz Miles at Coventry University and Jane Goodyer at Massey University. An important factor is that Liz and Jane have a long-term professional and personal relationship. Jane worked closely with Liz at Coventry University for 6 years, prior to her relocating to NZ. They have a positive working relationship that is also quite informal. They thoroughly understand each other's nuances at a cultural and personal level. They also have quite similar work experiences and are at similar stages in their academic careers. They are also of similar age and both women. Interestingly gender has been studied in terms of its

influence on collaboration with findings suggesting that females collaborate more with females than male researchers do[19].

In terms of values, goals and expectations they have similar views about humanitarian engineering and how it can influence young people in a positive way. They both agree that it can influence those who are typically alienated from learning about STEM. The only difference in their goals relates to who they target the outreach programme to. Coventry University is striving to disseminate humanitarian engineering to 14-21 year olds, irrespective of gender, and is including young people who are either excluded or at-risk of school exclusion, newly arrived to the UK refugees or asylum seekers. Massey University is targeting young girls aged between 10-13, who will come from lower decile schools (i.e. have a higher proportion of students from low socio-economic communities) and will include girls that come from regions in NZ that have a higher proportion of Maori and Pasifika population.

It is quite clear that the personal antecedents of the two partners mirrored each other, making collaboration much easier. Also, it is important that there is flexibility in how partners pursue the goals to aid collaborative effort.

Antecedent Condition – Physical Environment

The UK and NZ are at opposing sides of the planet. The extreme lack of spacial proximity has created many challenges. Many of the challenges encountered by the UK and NZ are not unique to this section of this article and have been discussed in relation to Stokols' model earlier in the paper. However we have tried to overcome these by the extensive use of Skype and email communication methods. The time difference (typically 11-13 hours) does mean that both partners have to be willing to engage in Skype meetings outside of normal work hours, sometimes late into the evening or early in the morning.

To cope with such physical displacement we suggest that collaborators must be willing to use technology to communicate and are able to work flexible hours.

Antecedent Condition – Bureaucratic and Structural Issues

Massey University acknowledges the importance of developing innovative, collaborative, multi-institutional partnerships to sustain world-class research and scholarship in its Research Strategy. However, Massey University does not have systems nor policies in place that focus on establishing and nurturing collaborations, particularly international. This is fundamentally different to Coventry University that has recently introduced 'Internationalisation' into its merit review system as a compulsory requirement for all academic staff. There is a broad spectrum of activities that can be categorised as 'Internationalisation', which can range from internationalisation of curriculum through case studies through to taking students overseas to study. The university has provided large scale investment to encourage academics to engage in this activity and it will be interesting to review the impact of this change in the merit system on engagement with the UNTWIN by Coventry academic staff.

Coventry University has also received support from its bureaucratic structure (i.e. the Faculty of Engineering and Computing) to release resource to develop the humanitarian outreach programme. They have developed ten outreach workshops with approximately £18,000 funding from the Royal Academy of Engineering, with assistance from industry (Siemens),

academia (University of Bristol), private organisations (ReciproBoo) and non-govermental organisations (Serve On, Practical Action). Each workshop contains facilitator support materials, links to the UK's national curriculum, kitsets, student support materials and 'train-the-trainer' support.

At Massey University there are institutional drivers that create support for this work. For example, in NZ there is a national performance-based research fund (PBRF), which funds universities. This is measured by publications, research funding, peer esteem, etc. Currently the NZ government, through its Ministry of Business, Innovation & Employment[20] have launched a $2 million fund to excite and engage harder-to-reach young people (e.g. indigenous Maori or people from low socio-economic communities) to take part in STEM. Jane Goodyer is bidding for $130k to adapt the UK programme into a national free afterschool club, called the Hello Café. If the bid is successful the research outputs, i.e. related to womens' engagement with STEM, will contribute to Jane Goodyer's PBRF rating and the university's goal to increase the research funding from PBRF.

This collaborative effort could be described as an organic and voluntary collaboration rather than one which has been developed by an administrative, bureaucratic system, which supports the argument that collaboration works best as a voluntary process[21]. However, the strategic goals and performance measures of universities does play an important role in allowing time and resource to be released to undertake collaborative work.

Conclusions

The future challenges and complexity the practice of engineering will encounter, such as population growth and a global economy, increases the importance of the engineering education community to develop a skill base that can effectively work with others within the engineering community, other disciplines and other cultures. However collaboration across differing nations and disciplines is difficult. The UNESCO UNITWIN is an excellent programme that brings together intersectoral and interdisciplinary partners, however there is an assumption that these partners have the skills and systems to effectively collaborate. Our experience has shown that the four founding partners of the UNESCO UNITWIN in Humanitarian Engineering had differing capability and experience to effectively collaborate from day-one of the network's formation. It has taken some time for the partners to come to grips with working together. Writing this paper has provided us an opportunity for reflection about how we are operating the UNESCO UNITWIN and by engaging with literature about the 'science of team science' has unveiled a myriad of ideas and theories that we should have taken account of at the network's inception. Our experience mirrors what other transdisciplinary programmes experience, what isn't apparent is the mutual learning that can occur by systematically sharing our experiences more widely. As an engineering education community we need to ask ourselves how we're equiping engineers of the future to effectively collaborate at a global level and also what professional development is required to help ourselves advance in the 'science of team science'.

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