



Engineering and Physical Sciences
Research Council

Evaluation Report

Evaluation of the Engineering and Physical Sciences
(EPSRC) Bridging the Gaps Scheme

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Executive Summary

The purpose of the evaluation is to assess the impact that the *Bridging the Gaps* (BTG) scheme has had on the cross-disciplinary culture at institutions while also reflecting on the current investment. The outcomes will be used as input to future programme strategy development and to enhance the operation of the scheme as appropriate. *Bridging the Gaps* was set up to fund cross-disciplinary work across higher education institutions in the UK

Key findings, Successes & Recommendations

Sustainability of Collaborations formed

Further detail about these findings can be found in 4.1 of the full report

Key findings

Bridging the Gaps has been successful in establishing 'new' as well as developing existing partnerships, collaborations and networks.

Many institutions have stated that researchers have achieved funding from proposals created from the collaborations formed through *Bridging the Gaps*.

Key Successes

Bridging the Gaps funding has led to high-level collaborations, surpassing many institutions expectations.

Majority of institutions involved have seen an increase in the amount of new collaborations being created within Cross-disciplinary Research

Key Recommendation

'Sustainability' hard to determine, due to time constraints of scheme.

Need to highlight most consistent collaborations and help maintain initial networks created through *Bridging the Gaps*.

Impact on Institution/Research Strategy

Further detail about these findings can be found in 4.2 of the full report

Key finding 1

100% of responses stating that *Bridging the Gaps* had an impact within the institution however the nature of the impact varied greatly and also some concern over the longevity of the impacts.

Key finding 2

Cross-disciplinary research is now part of many institutions 'strategic plan' and the majority of institutions have stated an increase in cross-discipline proposals being submitted.

Key Successes

Bridging the gaps has raised awareness of the importance of cross-disciplinary work, causing a shift in the way research is funded with many institutions being much more geared towards funded interdisciplinary research.

Key Recommendation

a) Need to visit institutions 'ad-hoc' to see if a 'cultural change' has occurred

b) Need to carry out another (more in-depth) evaluation when all institutions have finished their projects to see if *Bridging the Gaps* has impacted the institutions in the long term.

Institutional Support

Further detail about these findings can be found in 4.3 of the full report

Key findings

The institutions have embraced the scheme with two thirds (66.6%) of responses stated that their Institution provided support in addition to the *Bridging the Gaps* award.

Following the success of the *Bridging the Gaps* scheme, a small number of institutions have continued the scheme by funding it internally

Key Successes

Institutions have continued the scheme in some capacity by providing leverage to help continue support cross-disciplinary research

Key Recommendation

Need to create mechanisms to help institutions continue supporting cross-disciplinary research.

Impact on People

Further detail about these findings can be found in 4.4 of the full report

Key findings

Many of the most successful BTG funded projects are the products of strong partnerships.

Early career researchers were much more open to cross disciplinary collaborations although this partly can be attributed to the funding streams made available to them. Many researchers whose work was funded by *Bridging the Gaps* have developed vital interpersonal and organisational skills which have helped further their careers.

Key Success

Bridging the Gaps has had a direct impact on early stage researchers. In addition, BTG led to the acquisition of valuable skills, and knowledge transfer between disciplines

Key Recommendation

- a) EPSRC might consider seeking new opportunities to bring the established collaborations/partnerships into contact with other funded researchers from institutions.
- b) EPSRC needs to assist institutions in maintaining most successful partnerships / Networks

1 Introduction

Bridging the Gaps is a scheme at EPSRC that is currently managed by the Cross-Disciplinary Programme (C-DIP).

1.1 Background to the Cross-Disciplinary Programme

C-DIP is a relatively new research base programme. In 2008 EPSRC undertook a major restructuring exercise and, as a result, the Cross-Disciplinary Interfaces Programme (C-DIP) was formed. Prior to C-DIP, EPSRC focused on the engineering and physical science/life sciences interface through the Life Sciences Interface (LSI) programme

C-DIP aims to enable UK engineers and physical scientists to be world-leading in research and training at existing and emerging cross-disciplinary interfaces. Our specific objectives are to:

- Fund transformative research at **targeted** cross-disciplinary interfaces
- Support the next generation of talented cross-disciplinary researchers throughout their academic careers
- Maximise knowledge exchange between academic disciplines
- Contribute to knowledge exchange between academia and users of **cross-disciplinary** research
- Identify new **research and training** opportunities at cross-disciplinary interfaces
- Proactively manage relationships with key stakeholders at the interfaces

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Although C-DIP's remit is, in principle, all of EPSRC's remit and the interfaces with all the other research councils, it is not possible for the programme to cover and work at all of these interfaces. C-DIP's role is not to duplicate the work of the other research base programmes but to intervene at targeted interfaces that are a priority for EPSRC.

Our current priority areas include:

- Complexity science
- Maths of Life
- Engineering and physical sciences research pertaining to stem cells
- Cross-disciplinary approaches to novel technology development
- Engagement with the social sciences
- The interface between physics and the life sciences – supported through responsive mode signposting in partnership with the Physical Sciences Programme

1.2 Background to the Bridging the Gaps Scheme

EPSRC encourages a multidisciplinary approach to research especially when tackling major research challenges that will have societal and economic impacts.

Developments in one discipline often underpin others, or lead to new challenges in other research areas. In addition, many important emerging research areas are on the interface between traditional disciplines. It is therefore important to remove barriers and provide opportunities to collaborate.

EPSRC wants to encourage researchers to bridge the gaps between their disciplines and work creatively together.

The aim of Bridging the Gaps (BTG) is to empower Research Organisations to design a programme of activities that will stimulate creative thinking from the individuals involved, and that reflect institutional strengths and strategies. The objectives of this initiative are to:

- Initiate **new**, long-term collaborations between researchers across the EPSRC remit and beyond;
- Stimulate innovative approaches to collaboration between disciplines;
- Increase the cross-fertilisation of ideas and the take up of advances across the boundaries between disciplines;
- Enable Research Organisations to encourage and embed multi-disciplinary research between departments and alleviate barriers to collaboration.

The Bridging the Gaps (BTG) Scheme was initiated in 2006 with the first two rounds of awards focusing on the development of collaborative research programmes crossing the mathematical sciences, ICT and engineering (in 2006 and 2007). In 2008 the scheme focused on EPSRC's Mission Programmes – digital economy, energy, nanoscience and next generation healthcare. While in 2009 the remit of fourth round was expanded to encourage applications that bridge the gaps between engineering and physical sciences (EPS) and other non-EPS research areas. In particular, EPSRC welcomed proposals that included interfacing with the social sciences and/or arts and humanities.

To date, *Bridging the Gaps* has funded four rounds of awards (from July 2006 to March 2010) which equates to 23 awards totalling £10.5m of funding. The evaluation will primarily be carried out for internal purposes with the ownership lying with the Head of the Cross-Disciplinary Interfaces Programme. The 'customers' of the evaluation will be the Cross-Disciplinary Interfaces Programme and EPSRC as well as its advisory bodies, The C-DIP SAT, TOP and UP, and those involved with promoting cross-disciplinary working within EPSRC.

The ethos underpinning *Bridging the Gaps* is that many issues and problems facing the world today cannot be solved through research in one discipline alone; solutions are found when different perspectives, competencies and interests are brought together.

2 Purpose and objectives of the study

The overarching objective of this study is to assess the impact that the *Bridging the Gaps* scheme has had on strengthening the multidisciplinary culture and activities within institutions, while also reflecting on current investment. The study will also provide input to future programme strategy development and enhance the operation of the scheme as appropriate.

In evaluation terms, the study is required to determine the effectiveness of the programme, and the extent to which it has made progress on one or all of its central objectives and the impact these have had at the institutional level and on individual researchers. Specifically, the review will investigate the extent of partnership working as a result of *Bridging the Gaps*, and the sustainability of collaboration. The project will explore whether and how researchers continue to, or intend to, work together once the *Bridging the Gaps* funding finishes.

The programme has some novel features in respect to its funding arrangements and has evolved through four successive funding rounds and as such, the evaluation is also required to consider the operational aspects of the scheme, and to learn lessons about the aspects that worked well and any one might practicably change in order to increase effectiveness.

The programme aims to encourage researchers to bridge the gap between their disciplines through providing funding for people based activities centred on novel approaches to cross-disciplinary interaction and collaboration. Importantly, these activities are intended to stimulate wider long-term culture change with respect to cross-disciplinary working within participating institutions.

Therefore the study seeks to evaluate the impact of the BTG scheme in terms of the cultural change on the participating institutions as well as in terms of specific objectives of the BTG scheme:

- Sustainability of collaboration formed
- Impact on Institution
- Impacts of research strategy
- Institutional support
- Impact on people

3 Methodology

The review was carried out using a mixture of methodologies, summarised below:

The consultation with (i) Pro Vice Chancellors, (ii) the survey of BTG PI's and (iii) the survey of wider researchers including a few select CI's, project administrators and participants who received funding or are involved with Bridging the Gaps;

- A small number of preliminary semi-structured telephone interviews were conducted with six participants who have been involved with Bridging the Gaps to improve understanding of context
- Survey/data collection tool. In the form of two online surveys for the BTG PIs; online survey 1 targeted institutions that had finished BTG or who's currently underway with BTG. The second online survey was designed for the projects that had yet to start the scheme.
- Questionnaires were also sent by written consultation (by letter) to the Pro Vice Chancellors of each of the 23 institutions involved in *Bridging the Gaps*
- Questionnaires were sent to the Principal investigators to forward on to participants involved in the scheme but who was not part of the core team i.e.researchers, project administrators.
- All of the methods used requested respondents to identify and provide brief exemplars that illustrate outcomes and impacts against the key programme objectives and evaluation issues (innovative approaches, new sustainable collaborations, impacts on research strategy etc)

An online survey methodology was selected for the survey of the BTG Principal Investigators (PIs) as this is the most efficient route by which to determine which programme objectives have been progressed most, and to identify specific cases of impact. The PIs have a view on programme design, focus, delivery arrangements and administrative efficiency more generally.

In terms of questionnaire design, the intention was to use a combination of closed questions and open questions. The closed questions, with appropriate ratings or intervals, permit a degree of quantification and expedite the process of completing a return, whereas the open questions allowed us to gather qualitative information to permit people to express their sentiments more fully on key issues, offer suggestions on practicable ways to further improve the programme going forward and provide us with specific exemplars of outcomes and impacts.

The consultation with Pro Vice Chancellors (PVC) required a different approach by focussing much more on strategic issues. Therefore a set of

appropriate questions were developed. These were largely open questions to gather qualitative data on issues such as changes in institutional research strategy, wider implementation of the approaches developed under BTG, staff incentives for cross-disciplinary working etc. The Pro Vice Chancellors' were invited to provide a written contribution to the study against these questions in a template format. We also requested outcomes and impact exemplars from this group of stakeholders.

For the survey of a group of wider researchers, the PIs of each BTG grant were be asked to provide contact details for researchers in the research groups/departments participating in the BTG activities. In order to gauge a wider perspective of the impact of 'Bridging the Gaps', the survey was designed for individuals who were involved in the scheme but were not part of the core team.

Once representatives have been identified for the evaluation, EPSRC sent introductory letters and emails to the Pro Vice chancellors and Principal Investigators explaining the aims and objectives of the evaluation with a request for them to identify further contacts to the company, as necessary.

4 Analysis of Key Findings

N.B. Please note that for the analysis the majority of findings and conclusions are from telephone interviews, responses by the Pro-Vice chancellors and other academics involved in the scheme, and from the institutions from the first round of *Bridging the Gaps* which have finished the scheme. There are a few quotes and results from institutions that are currently underway in *Bridging the Gaps*

4.1 Sustainability of Collaborations formed

One of *Bridging the Gaps* objectives was to encourage researchers to bridge the gap between their disciplines, in terms of results BTG has achieved this goal and as a result the majority of institutions have seen an increase in the amount of new collaborations being created within Cross-disciplinary Research.

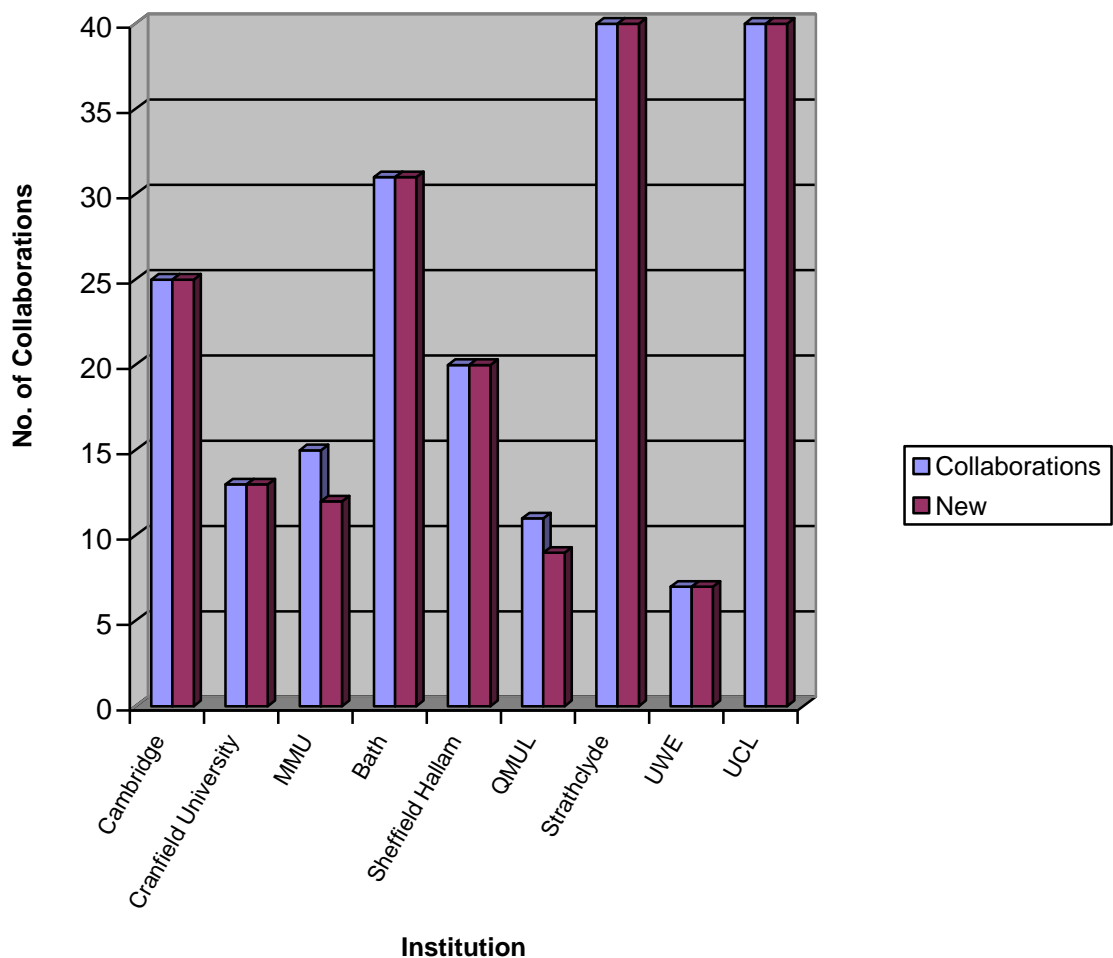


Figure 1: No. of new interdisciplinary Collaborations

Due to the nature of the award, institutions were given free reign in how they funded proposals and how many projects they funded. The volume of cross-disciplinary projects funded increased with 75 % of institutions said that they awarded at least + 10 projects. These findings could be attributed to the

award allowing institutions to fund 'riskier' projects that otherwise may not have been funded.

The scheme has been successful in creating new collaborations for example; Heriot-Watt University have now over 30 separate interdisciplinary collaborations between mathematics at the Maxwell Institute (the joint research institute between University of Edinburgh and Heriot - Watt University) and researchers from other disciplines.

The scheme has also been successful in impacting the wider community, creating further interest and leverage as a total number of 27 'follow-on' grants/projects have already been awarded to the four institutions that have finished the original *Bridging the Gaps* award

Examples of follow on success which can be directly attributed to BTG funding;

- EPSRC awarded University of Strathclyde £458,563. The *Bridging the Gaps* award has led to nine grants been awarded to the value of £3,620,091 including securing a Knowledge Transfer Account (KTA) grant from EPSRC to the amount of £2,641,402 (grant reference EP/H50009X/1).
- University of Bath have also been successful in securing grants which 'follow on' from BTG. In particular they secured one major grant by the Leverhulme Trust, "Application of multidisciplinary optimisation for sensor and manufacturing network designs", awarded in June 2009 to the value of £161k. This is claim as a direct outcome of our endeavours at engaging researchers between computer science and mechanical engineering.
- University of Bristol received an additional award from EPSRC for £201,720 for University of Bristol Bridging of Gaps Cross-Disciplinary Feasibility Account (grant reference EP/H024786/1).

Funding was awarded to the institutions to support universities in their approach to nurturing multidisciplinary and interdisciplinary research. The support offered was flexible and institutions were/are able to carry out a range of activities funded by *Bridging the Gaps*. The events/activities were the key to enabling the establishment and development of new networks/collaborations and partnerships.

Events

Recipients of the *Bridging the Gaps* funding undertook a range of activities and events that encouraged researchers to explore the benefits of cross-disciplinary collaboration.

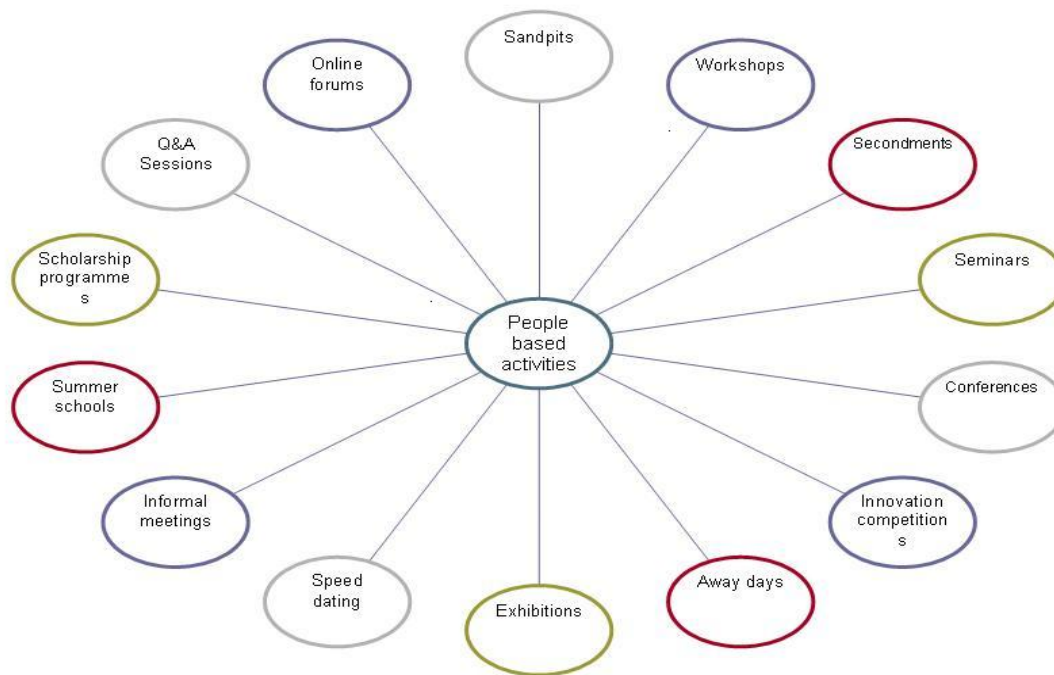


Figure 2: Range of activities undertaken throughout the Scheme

As shown above in Figure 2, activities undertaken focussed primarily on fostering and developing new partnerships and collaborations. Each institution involved used different activities to bring people together as a consequence of this; there is not a particular activity which has proved ‘most successful’.

Instead institutions found that being able to use different activities worked at different stages of the scheme and by using a range of activities proved beneficial for establishing new partnerships and collaborations as it allowed the institutions to be flexible in their approach.

Professor Kalawsky, Loughborough University “The creation of an interdisciplinary research school in systems engineering (the underpinning discipline behind the BTG award) was greatly facilitated by the mechanisms put in place by the BTG award. I honestly feel that the diversity of methods was the key behind the University's decision to continue with interdisciplinary research schools. The co-sponsoring of a showcase event brought academics together who had never met each other before. The award of good prizes for the best poster encouraged a competitive element that led to great posters which have been used to inform academic colleagues across the campus about what is done. Prior to this event the work was kept behind closed doors. This was showcasing was repeated at the BTG co-sponsored International Conference. This really brought not only the Loughborough systems community together but initiated further international collaborations”.

69% of PIs stated that activities/events held to promote *Bridging the Gaps* brought more than 50 people together. In fact some institutions have been

extremely successful in bringing academics from different disciplines together.

For example, in the final report provided by University of Cambridge it stated that “At its inception two years ago, *CbS*’ the membership consisted of 25 Research Ambassadors from six University departments, supported by four industrial partners. Today *CbS* counts more than 550 active members and the name *CamBridgeSens* is internationally identified with sensor research at Cambridge University. Web traffic statistics show that *CbS* now acts as the main portal for external researchers and Industry to find links to sensor research ongoing in Cambridge”.

	July 2008	June 2010
Academic membership	25	550+
Participating departments	6	15
Industrial membership	4	60

Table 1: *CamBridgeSens* network growth

Some universities used novel mechanisms to bring people together; Manchester Metropolitan University used ‘Early Adopter grants’ which aimed at funding small ‘seed’ projects. The format allowed work on interdisciplinary projects to test feasibility or act as pilot projects for ideas that may not otherwise have been funded, particularly given the focus on early researchers.”

Robert Donnan, Queen Mary, University of London being involved in BTG has “led to me being awarded an EPSRC Bright IDEAS award in Chemistry to the value of £240k over 18 months (grant reference EP/I008632/1)

University of Bristol found the speed dating style networking initiative a surprising success in fostering the most number of links and collaborations in the shortest period. An example of a successful partnership formed from bridging the Gaps is Dr Francesco Mezzadri from the Department of Mathematics and Prof Jon Keating who is considering new collaborative research that arose from bridging the Gaps.

Dr Mezzadri stated that the grant allowed them to be put in contact with Toshiba TRL concerning research topics in modern Telecommunication that needed expertise in a branch of mathematics known as Random Matrix Theory.

So far this collaboration led to

- Two undergraduate summer projects founded by Toshiba TRL. One in 2008, the other in the summer of 2010. The student in 2008 was Nicholas Simm, who is now a postgraduate student working in the Mathematics Department

- Dr Justin Coon from Toshiba TRL and Francesco are preparing a bid for a European Training Network for postgraduate students involving seven European nodes in the UK, Italy, Germany, France and Poland. The involvement of an industrial partner will be an essential component of the Network.

Professor Askes, University of Sheffield (telephone interview, appendix 5) “One unexpected outcome from BTG is the formation of a whole new research group ‘the fluid mechanics’ which consists of researchers from the mechanical, chemical and maths departments”. Professor Askes states that the fact that the institution now has a team of investigators (fluid mechanics) who have established a trust between each other and will work together in the future illustrates the success of the scheme.

Professor Yao, University of Birmingham – “The BTG project has set up a number of collaborations within the University that will continue past the end of the project.”

Bridging the Gaps has achieved its aims to encourage researchers to bridge the gap between their disciplines through providing funding for people based activities centred on novel approaches to cross-disciplinary interaction and collaboration. As a consequence, these activities have stimulated a wider culture change with respect to cross-disciplinary working within participating institutions in the short term.

Professor Care, PI, Sheffield Hallam University – “The Bridging the Gap project has brought together academics from traditionally very distinct academic cultures e.g. science, engineering, fine art, sport, health. The diversity of disciplines has led to highly innovative research ideas”.

However, by bringing together academics from different discipline backgrounds has produced a result which was unforeseen. The emergence of a new ‘interface’ from cross-disciplinary research has caused issues. The new interface has also brought about a new ‘language’. In some instances this has already caused difficulty for researchers in being awarded follow on funding, due to exclusivity of the language.

Some institutions are also unsure where the new research should be situated, who to aim the research at (funding bodies) in order to be funded

These concerns have been reiterated throughout the evaluation process; EPSRC needs to establish the mechanisms to cope with the new ideas being formed.

The range and flexibility of activities has had a direct impact creating an environment within the institutions which nurtures interdisciplinary working and has established new partnerships and collaborations. These partnerships and collaborations are already producing cross-disciplinary proposals some of which have been successful in follow on funding.

The new collaborations which have emerged from the events/activities are already producing research that is gaining interest and even a few have been publicised as a direct result of BTG funding. University of Bath have stated that five collaborative research projects funded by *Bridging the Gaps* have already been referenced in published papers.

4.2 Impact on Institution

The main aim of the evaluation is to assess the impact that the Bridging the Gaps (BTG) scheme has had on the cross-disciplinary culture within the institutions including impact on research strategy.

Culture provides a set of norms which define the way an organisation sets about achieving its objectives (including both the written and the - sometimes more powerful - unwritten rules). Culture also provides social cohesion. Changing culture is risky as an organisation's culture represents an important element in organisational (and individual) identity. It provides stability and guidance.

Culture change requires an understanding, commitment, and tools. *Bridging the Gaps* provided the tools to establish an environment for cross-disciplinary research to flourish. All 23 institutions articulated interest in the scheme for numerous reasons but specifically they understood the importance of cross-disciplinary research and all institutions involved were/are committed to the scheme and to development and promotion of cross-disciplinary work (see Institutional Support chapter 4.3). However, the level of “culture change” within the institutions is not yet known as the project has finished in only four institutions.

An element of the initiative which has been well received by the management of the institutions is the fact that the money is there for the institutions to make quick funding decisions subsequently the institution can react quickly to new ideas and help turn the new innovative ideas into viable research. The ‘impact’ of the scheme is hard to determine due to the varying nature of the four round of calls and the period of time in which the project is carried out may not be enough time to create a “cultural change” within the institutions.

Although stating the limitations of assessing the impact, an example of a “cultural change” occurring within an institution is **University of Reading, Professor Saddy** (Principal investigator) stating that “BtG was instrumental in the decision to choose neuroscience as a research priority area. Also was a deciding factor in the decision to fund CINN (the Centre for Integrative Neuroscience and Neurodynamics). It has also had a big impact on hiring strategies”

This statement is very important as ‘Culture’ frequently echoes the prevailing management style, with managers tending to hire people like themselves the established organisational culture is reinforced by new hires.

By stating that BTG has had a big impact on hiring strategies, it highlights that the University is changing the way it thinks and recognises the importance of how people ‘fit’ into the organisation i.e. if they have a cross-discipline background. The key to obtaining “culture change” is to involve the employees in each step of the process.

The varying responses' from online survey 1 regarding the way BTG has impacted their institution are illustrated in the below graph:

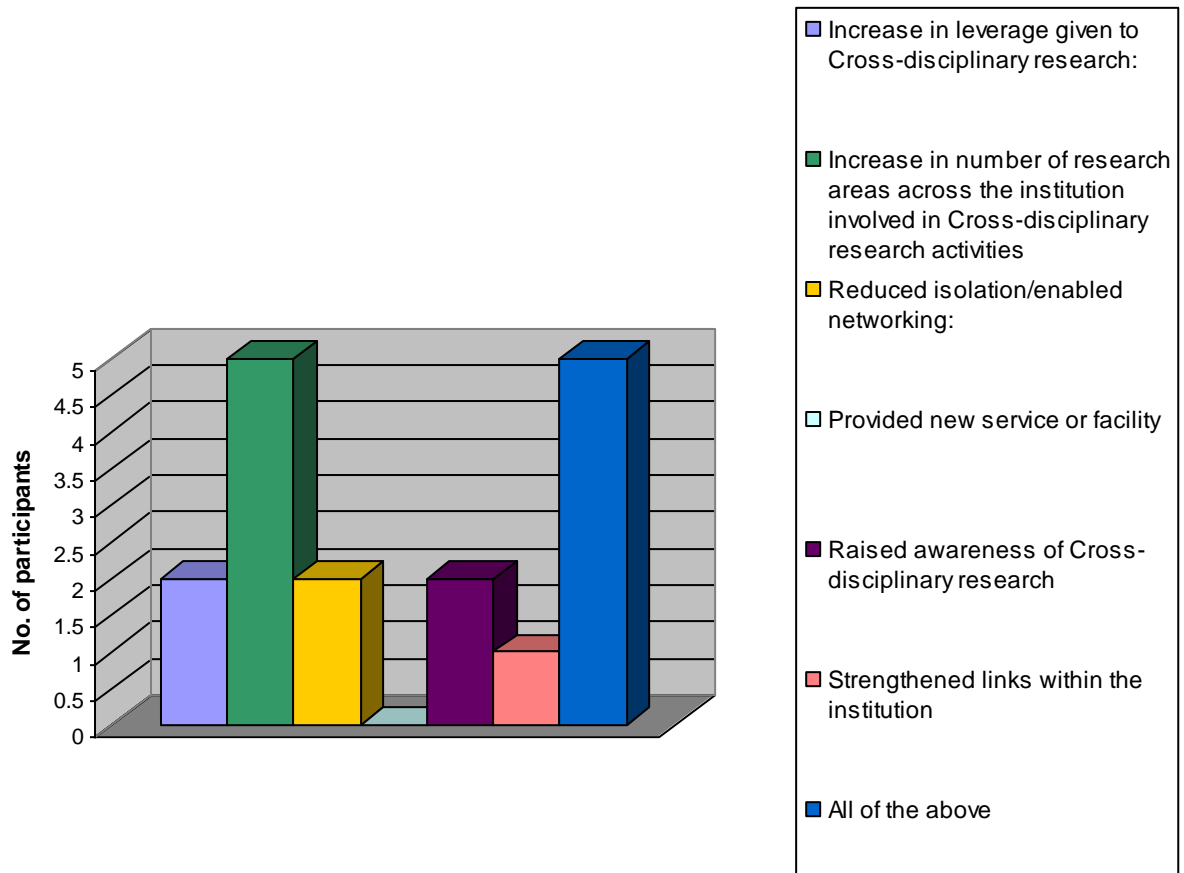


Figure 3: What has been the biggest impact of ‘Bridging the Gaps’ within the institution

Below are a few more examples of “culture change” occurring within institutions;

University of Strathclyde, PVC – “The thinking behind the BTG award has also led us to establish the Institute for Advanced Studies which involves several other universities across Scotland”.

Professor Friend, PVC, Cranfield University – “The award has had an impact widely across the university with increased collaboration across the host department, all of our schools and both of our campuses. The award has led to the creation of a ‘Cranfield Nano community’ to facilitate ongoing collaboration beyond the life of the award”.

Although it is incredibly difficult to assess if a “cultural change” took place within the institutions involved, 100% of responses received did state that *Bridging the Gaps* had an impact within their institution but the capacity in which it did varied greatly and there is a real concern over the longevity of the impact.

4.2.1 Impact on Research Strategy

One of the central ways in which *Bridging the Gaps* has impacted the institutions is how multi/cross disciplinary research is now an important element in the research strategies of the majority of institutions involved in the scheme.

Some institutions became involved in the scheme as it aligned with their own research strategy for example; Cranfield University research strategy focuses on multi-disciplinary collaborative research.

The infrastructure and research strategy of a few institutions is very much geared towards multidisciplinary collaborative research such as Keele University who have nearly sixty years of experience in crossing traditional discipline boundaries. However Keele University like other institutions “wanted to continue to nurture research collaborations that produce novel and diverse approaches to complex research problems” **Professor Jones, PVC, Keele University.**

The *Bridging the Gaps* initiative may have helped in publicising the cross-disciplinary work completed and also the research currently in development within institutions.

Other institutions have seen a major impact on their research strategy; a few examples are as follows;

Strathclyde PVC – “BTG has become a major element of University strategy with a large proportion of university level research funding being allocated through the continuing BTG programme. The programme has been adopted university-wide, and has proven as popular in the social sciences as it was in the STEM disciplines. BTG was also part of the university’s successful KTA bid. Within the institution, the BTG team initiated a meeting of researchers working in health at a University Research Day event, which has now led to the development of a formal cross disciplinary group called ‘Strathclyde Health’ that, will be explicitly mentioned in the new university Strategic Plan. The university strategy envisages both consolidation of multi-disciplinary group into cross-university initiatives and the continued use of more dynamic BTG type approaches to bring together researchers to focus of new problems.”

Professor Saddy, PI, University of Reading “We intend to continue with the summer schools, technical training workshops, and neuroscience seminars established by BtG. We have also developed linkage with the Institute for Cardiovascular and Metabolic Research which will continue. We have developed the managerial infrastructure necessary to promote interdisciplinary; we hope that this will be carried on, specifically by continuing the position of Interdisciplinary Research Development Manager after the end of the grant.”

The continuation of the Interdisciplinary Research Development Manager at University of Reading illustrates the institution's recognition of the importance of interdisciplinary research.

Professor Miller, Heriot-Watt University “The University was moving towards establishing new cross-school models of working through its Focus on the Future strategy when *Bridging the Gaps* proposal was submitted. The Bridging the Gap project reinforced the ideas strategy in this policy and exemplified the benefits from cross-disciplinary research”.

Professor Kalawsky, Loughborough University “The BTG has facilitated the Research School of Systems Engineering by providing linking themes. The University have fully embraced the idea of Interdisciplinary Research Schools as part of its strategic plans. Consequently at the start of the BTG project only 3 Research Schools were initiated. This has now grown to 5 and a further 2 are being planned. Interdisciplinary research schools are considered a fundamental part of the university future.”

The creation of new research schools demonstrates a clear shift towards supporting cross-disciplinary research by investing heavily in the infrastructure for the future.

Although it is difficult to identify specific impact on strategy due to the timescales of the scheme BTG has “contributed to the evidence base supporting the value (both in research outputs and future income generation) of cross-disciplinary research and provided some useful learning on the degree of direction and coordination required to maximise the return on investment” – **Professor Jewell, University of Sheffield**

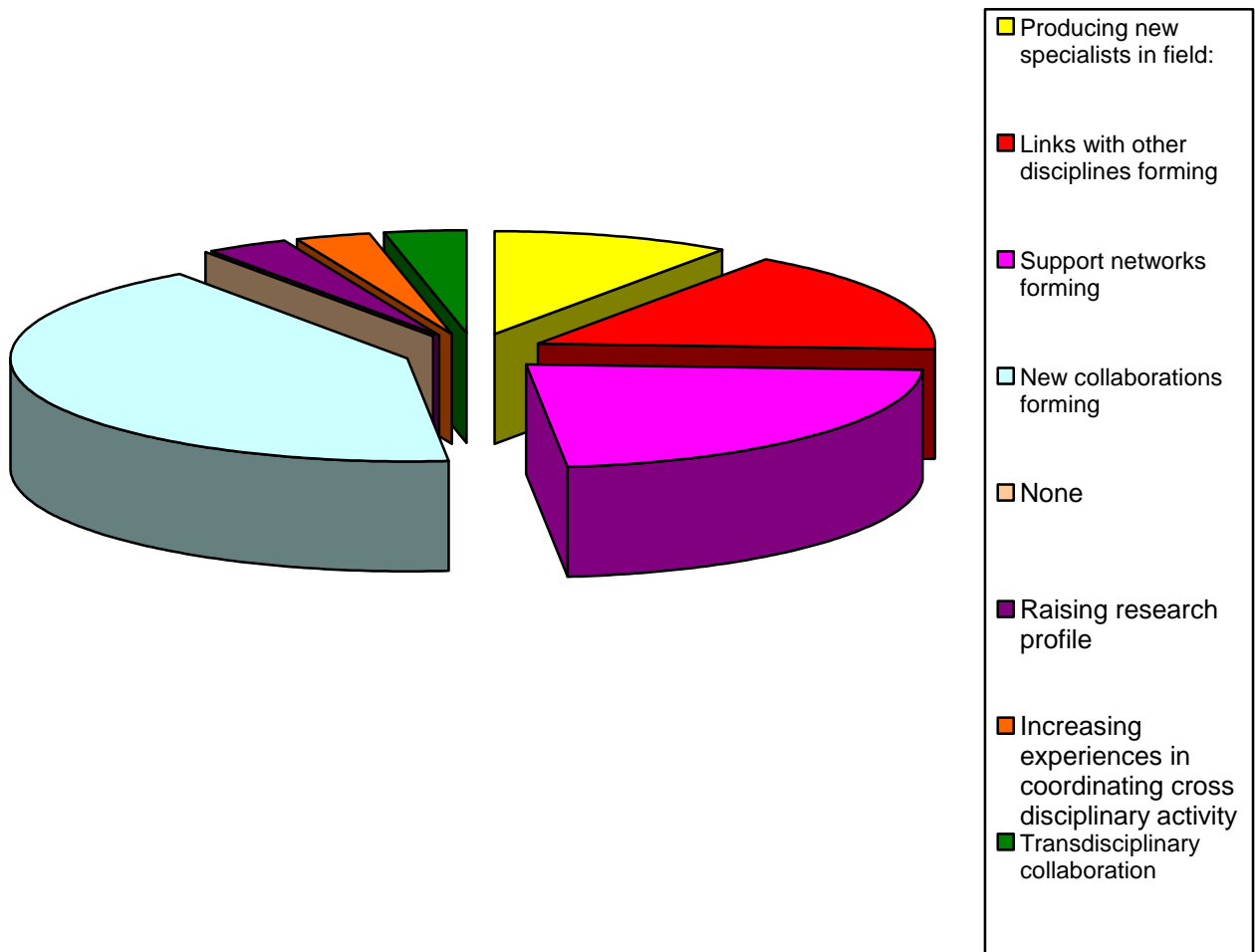


Figure 4: Bridging the Gaps was successful in publicising the cross-disciplinary work completed and also the research currently in development within institutions

The extent to which Bridging the Gaps has impacted the institutions and their research strategies is hard to determine in the long term however most individuals asked did think it has impacted them a on personal and institutional level and the progress made within institutions in cross-disciplinary will continue beyond the award.

4.3 Institutional Support

As *Bridging the Gaps* awards are institutional awards, the support and involvement from the institution is fundamental to the success of the scheme. The institutions have embraced the scheme with two thirds (66.6%) of responses from online survey 1 stating that their institution provided support in addition to the Bridging the Gaps award. Each BTG award has experienced different levels of engagement from the institution.

Below are the following ways in which institutions provided additional support:

- Co-organising & partial funding of workshops
- Funding additional fellowships & PhDs
- Teaching & administrative workload relief
- Additional financial commitment throughout & beyond award
- Encouragement & 'moral' support – top level management attending events

A few institutions have continued the scheme in some capacity by providing leverage to help continue support cross-disciplinary research, for example University of Bristol obtained follow on funding *Bridging the Gaps, Feasibility account' value £201,720*.

Professor Ian Cluckie, Pro-Vice-Chancellor (Science and Engineering) Swansea University “The institution has provided over £60K for two rounds of funding for BTG seedcorn funding. In addition, the Planning and Strategic Projects Unit will provide funding to make the Programme Manager post a full-time equivalent”.

Professor K C Parsons, Pro-Vice-Chancellor (Research), Loughborough University “The University further supported the PI by appointing him as the Technical Head of the Systems Engineering Innovation Centre in addition to his role as Director of the Research School. The Centre represents a unique £60M collaboration between the University and BAE Systems and BTG award has helped facilitate further development of the Centre to include other industries and to encourage wider academic engagement across campus. Interdisciplinary mechanisms and approaches developed via the BTG award have achieved high impact on the Centre and how it undertakes research across the systems cross disciplinary boundary”.

All 23 institutions have illustrated commitment to the scheme in some capacity; the commitment of the employees at all levels is the key to keeping the ideals of the initiative alive and instrumental in achieving “culture change”.

4.4 Impact on People

Bridging the Gaps has not only created new partnerships/collaboration but has had an impact on the way people think about Cross-disciplinary research, igniting their interest in cross-disciplinary research and consequently institutions have seen an increase in the amount of cross-discipline proposals being submitted.

An example of this is **Karena Moore, University of Strathclyde, funded through BTG she graduated 2009 in product design** “*Bridging the Gaps* was the turnkey in starting my research career, I always had an idea for a project but it was not until I attended a workshop that I realised my idea was eligible for funding.”

Karena collaborated with researchers from a Chemistry and Chemical Engineering background. Karena is continuing with her research in a new team of academics she met through *Bridging the Gaps* as is now applying for the next call of the (NHS) NIHR, HSR 002 patient's experience.

Participants have mentioned how *Bridging the Gaps* has provided an opportunity to obtain valuable skills which they believe has aided them in developing not only their profile as a researcher but has in some cases had a direct impact on the progression of their cross-disciplinary careers.

Below are a few examples of this occurrence;

Strathclyde Non PI response – “the opportunity to collaborate with new partners across disciplines has created many new opportunities for all involved. We understand each others skills and approaches to a greater extent which has placed us in a better position for responding to new ideas and for developing and exploiting existing ideas to their potential”.

Nicholas Darton, Research Associate, department of Chemical Engineering and Biotechnology, University of Cambridge –“receiving this award has not only given me confidence in formulating my own research ideas but allowed me to demonstrate independent research ability that has proven to be crucial in lectureship interviews and fellowship application”.

Dr M Meier, Queen Mary, University of London “It has opened new horizons for me; more specially, a follow-up research study has been submitted and received successful funding through an 18-months £200,000 grant from EPSRC.” (Grant reference EP/H024662/1)

4.4.1 Early Career Researchers

Figure 5 (below) illustrates that 41% of participants involved in the scheme were early career researchers (ECR).

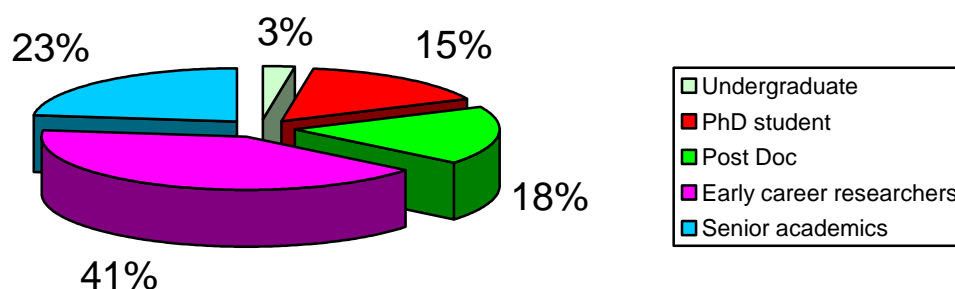


Figure 5 what was the general level of participants involved in 'Bridging the Gaps'?

There are many reasons why this is the case; institutions aiming the scheme towards the early career researchers, new joiners and ECR's were the most enthusiastic about the scheme, hard to get senior researchers on board as *'Bridging the Gaps'* was seen to be speculative in terms of career development however most institutions that as projects matured senior academics became very interested.

'Bridging the Gaps' has encouraged many researchers not just ECR's to think and work outside their own discipline, below are some examples;

Tanya Hutter, Chemistry, University of Cambridge - A 1st year PhD student who on her own initiative brought together skills and infrastructure from the Electrical Engineering department in optoelectronics, from Physics in nanostructure engineering, and chemistry to initiate a large scale project in toxin / pollutant detection developing a new integrated lab on chip technology platform seeded through the CBS initiative.

Pejman Iravani, University of Bath "As a young researcher, BTG has offered me the opportunity to establish new research areas and collaborations with other researchers and departments. In summary, the BTG has allowed me to start a promising new research area by providing the necessary first resources without which this progress would have been impossible."

Dr Jeanmeure, Formerly Research Associate at University of Sheffield (now University of Nottingham) “I decided to participate in the Bridging the Gaps programme, out of curiosity at first. Then, I found the experience to be very positive, especially the way it was organised: I applied successfully for a small grant funding with a couple of researchers from different disciplines. I am confident that listing the grant on my CV allowed me to obtain my current Research Fellow position at the Department of Mechanical Engineering at Nottingham. The Bridging the Gap exercise has to some extent motivated me to generate research proposal ideas that may not fit exactly in my current line of research, but could develop into something concrete by making use of my skills and experience when teaming up with other academics or research staff.”

The level of participants may be a direct consequence of the institutions involved recognised the importance of targeting early career researchers although the scheme was not aimed exclusively for ECR's, to get involved with the scheme as this particular demographic is seen as the future of cross-disciplinary research.

However, a possible explanation into why the majority of participants are ECR's could be that early career academics appeared to be more opened to collaborations within cross-disciplinary work and saw the scheme as a opportunity to achieve funding for novel and “riskier” project.

Throughout the evaluation another observation kept resurfacing of the difficulty to recruit senior academics to the scheme especially in the early stages of the project. **Dr Leo Caves, Pi, University of York** stated that it has been “hard to get senior researchers on board as ‘Bridging the Gaps’ was seen to be speculative in terms of career development and that if they were involved with the scheme they would neglect their academic research so some thought their time would be better served on their career. However junior colleagues were very keen to get involved and could see the ‘value’ in participating.”

There are numerous examples of participants at all stages in their academic career being influenced positively by their involvement in *Bridging the Gaps*. The success could be attributed to the **mechanisms/ flexibility** of the scheme which is designed to build the environment wherein new research ideas and cross-discipline networks can emerge by encouraging and developing the skills and ideas of academics but a scheme cannot be successful without the commitment and the enthusiasm of the participants.

5 Conclusion and discussion

The evaluation of *Bridging the Gaps* has produced some interesting results, however there is a great need to re-evaluate the initiative on an on-going basis and also after all 23 institutions have finished their projects.

The methodology used to carry out the evaluation consisted of a mix of both qualitative and quantitative methods, however due to the nature of the scheme and the purpose of the evaluation the majority of questions produced qualitative responses. This provided a more in-depth analysis of the impact of *Bridging the Gaps*, however due to the limited number of quantitative questions and also responses received the true impact of the scheme will not emerge (i.e. how many instances of academic collaboration within the institution has *Bridging the Gaps* directly facilitated) until the final reports have been submitted and follow on analysis is carried out.

Bridging the Gaps (from the responses received) has achieved its objectives in the short term however the difficulty is assessing the impact on a longer term basis as even though some institutions have finished their award the true impact requires time to surface, and in the grand scheme of the initiative is still in its infancy stage.

The funding is only for two to three years, this may not be enough time to develop relationships in order to see a major change within cross-disciplinary research. '*Bridging the Gaps*' is a good way of making contacts however the contacts need to be renewed which requires more funding and support from the institutions.

In addition to this, unfortunately due to the 'broad' remit, many researchers have had little or no success with other calls as the proposals look to be more suited to other research councils, as there is not currently cross disciplinary research/academics to review the new ideas being created.

Funding agencies need to recognise the importance of cross-disciplinarity in solving important problems which cannot be addressed appropriately within the confines of individual disciplines. *Bridging the Gaps* initiative is one of the first schemes to address this issue and has been successful in bringing people together from individual disciplines and with the inclusion of traditional disciplines, such as mathematics, the scope for cross-disciplinary has widen dramatically.

The emergence of a new 'interface' and 'language' is a continuing issue due to the nature of cross-disciplinary work. However schemes like *Bridging the Gaps* creates an environment in which academics can not only develop knowledge of different disciplines but they can also exchange research ideas and collaborate with academics from different disciplines, which can lead to high impact research results.

The merit of cross-disciplinary research is extremely difficult to judge, this is one of the successful elements of the Bridging the Gaps. As it bestows the power and judgement of proposals to the institutions who are more involved and aware of what research is happening within the institution.

¹Cross-disciplinary research is not something that happens effortlessly, this constitutes a major challenge for any research council wishing to promote such research.

The requirements for successful cross-disciplinary ventures were summed up by the Organisation for Economic Cooperation Development (OECD);

- all disciplines should be involved in the project from the beginning, including in the setting of the research questions and research methodology;
- clear leadership and coordination are imperative, with inter-disciplinary teams being most successful when they are in daily contact;
- an ability to cooperate with scientists from other fields is a minimum requirement, which involves the ability to fully grasp the core problems and basic theoretical assumptions of some other fields;
- the researcher who conducts inter-disciplinary research should be ‘an excellent specialist of a discipline. Highly competent proficiency in a single discipline is the only acceptable basis for inter-disciplinary success’ (OECD 1998, p.18); and
- inter-disciplinary research requires extensive networks, considerable time, and researcher mobility among disciplines.

In relation to the above reference by OECD, *Bridging the Gaps* initiative has been a success by creating an environment in which cross-disciplinary research can develop and emerge, however without the participants and institutions enthusiasm, effort and support the scheme would not have been a success.

Bridging the Gaps’ Impact on wider culture

- BTG has enabled the development of a critical mass of practitioners and of projects, which has helped interdisciplinary work to become widely recognised
- Bridging the Gaps funding was a fruitful and influential scheme for cross-disciplinary work within institutions
- BTG scheme has acted as a seed; for future collaborations
- The scheme overall has been a valuable catalyst for many new relationships to develop, at both an individual and an institutional level

From the evaluation, the overall opinion of those involved have found *Bridging the Gaps* a worthwhile, rewarding, and effective scheme to be part of and a scheme that should be supported in the future. To highlight the

Source: OECD/CERI, *Interdisciplinarity: Problems of Teaching and Research in Universities*, 1972, p. 25.

success of *Bridging the Gaps*, 100% of respondents would be involved in a similar scheme as it is seen as “Great idea from EPSRC, if used well, the money stretches a long way to stimulate exciting, world class research”

Professor Kaminski, University of Cambridge

The argument over whether or not *Bridging the Gaps* initiative provides value for money (£10.5 million funding spread across 23 awards) and whether the scheme should continue can be answered by the below quotes:

Mica Green, Coordinator, University of Cambridge – “Having seen the significant leaps in science achieved by researchers collaborating within CBS, I am now more convinced than ever that the future of science and technology lies in research that takes place between boundaries of historically defined scientific disciplines”.

Professor Saddy, PI, University of Reading “BtG has been transformative to the University of Reading. It has led to the university's investment in establishing the Centre for Integrative Neurosciences and Neurodynamics, has raised the institutional commitment to cross-disciplinary research, has been instrumental in the hiring of new faculty who have a commitment to the cross disciplinary endeavour, has allowed us to develop some managerial muscle for promoting research alliances across faculties, and has led to a flourishing number of cross disciplinary PhD students”.

6 Recommendations

EPSRC have received numerous suggestions from the responses received from the evaluation, on how *Bridging the Gaps* can be improved for future calls;

- Address the need to involve 'industry' from commencement of scheme to enable institutions to create products and markets that business and industry need to stay competitive
- Longer run time (follow on funding or on-going investment) to allow further development of networks/collaborations formed during BTG, these networks/collaborations could lead to a deeper 'cultural change' within the institutions
- Administrative load to 'demanding' for Principal Investigators – future call to allow more funding for administrative costs
- More involvement, higher visibility from EPSRC to illustrate support for the scheme
- Refine the themes of the scheme, calls 1 & 2 may have been 'too broad'
- Need to develop strategy on how to manage new 'language; that has emerged from BTG i.e. how to manage the cross-disciplinary research proposals being submitted from participants involved in BTG, need for 'hybrid' panel members
- EPSRC could play a stronger role in supporting the dissemination of successful projects
- Ongoing evaluative and analytical research needs to be undertaken of the characteristics of effective arts and science projects and their impacts

Appendix 1
Online Survey 1

Online Surveys

Develop, launch and analyse Web-based surveys

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Grant Details

Grid question example

1. What stage is your project at?

- Not started In progress Finished Continuing beyond award period
 Other (please specify):

2. How many research projects has 'Bridging the Gaps' funded?

- 0 1-4 5-10 +10
 Other (please specify):

3. How many people based activities have you organised?

- 0 1-4 5-10 +10
 Other (please specify):

4. What type were the people based activities?

- Workshops Seminars Sandpits Exhibitions
 Other (please specify):

5. Which methods did you find most effective/successful? Please specify why it proved so successful

6. Did you use any creative, novel mechanisms to bring people together? If yes, what were they and which proved most successful?

7. How many people have 'Bridging the Gaps' award brought together?

- 0-9 10-29 30-50 +50

8. What was the general level of participants involved in Bridging the Gaps?

- Undergraduate PhD student Post Doc Early stage academics
 Senior academics
 Other (please specify):

9. How far has 'Bridging the Gaps' encouraged early career researchers to think and work outside their own discipline?

10. Has 'Bridging the Gaps' had a positive effect on your or other researcher's careers? If yes, please provide details

11. Have you ever taken part in similar research grants before?

- Yes No Other

Personal Impact

12. Has the scheme help develop your personal skills?

13. Has the scheme helped you develop your knowledge in another research area? If yes, please provide details

14. Will you be implementing any new practices/processes as a result of the 'Bridging the Gaps' scheme? If yes, please provide specific examples

15. Do you think these personal effects would have happened to you anyway even if you hadn't participated in the scheme?

- Yes No Partly Other

16. Overall, do you think 'Bridging the Gaps' has been a success in terms of its effect on you?

- Yes No Partly Other

Impact on Institution

17. Has there been an impact on your institution due to 'Bridging the Gaps' award? If yes, please provide details

18. Did you receive any institutional commitment in addition to the 'Bridging the Gaps' award? e.g. workload relief

19. What has been the biggest impact of 'Bridging the Gaps' within the institution?

- Increase in leverage given to Cross-disciplinary research Increase in number of research areas across the institution involved in Cross-disciplinary research activities
- Reduced isolation/enabled networking Provided new service or facility Raised awareness of Cross-disciplinary research Strengthened links within the institution
- Other (*please specify*):

20. In which way do you think the 'Bridging the Gaps' award will have an effect on the institution in the future?
(select all that apply)

- Producing new specialists in field
- Links with other disciplines forming
- Support networks forming
- New collaborations forming
- None
- Other (please specify):

21. Overall, do you think the scheme has been a success for the Institution?

- Yes
- No
- Partly

Other (please specify):

22. Has 'Bridging the Gaps' has an impact on the institution's strategy? If yes, in what way?
(please provide examples)

Outcomes of 'Bridging the Gaps'

23. How many instances of academic collaboration within the institution has 'Bridging the Gaps' directly facilitated?

24. How many of these were new collaboration?

25. Has 'Bridging the Gaps' increased the number of grant applications collaborations being generated?

- Yes
- No
- Partly

Other (please specify):

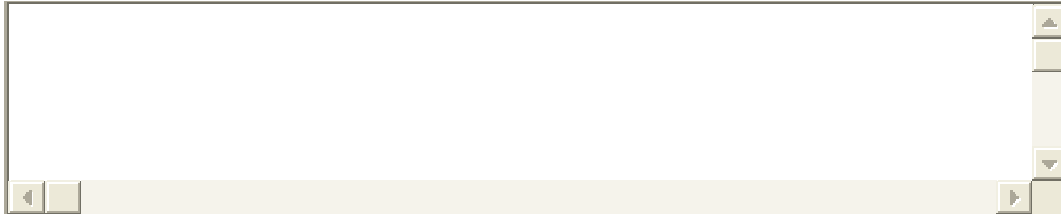
26. How many citations/publications have been produced as a result of 'Bridging the Gaps' funding

- 0-4 5-9 10-14 +15
 Other (please specify):

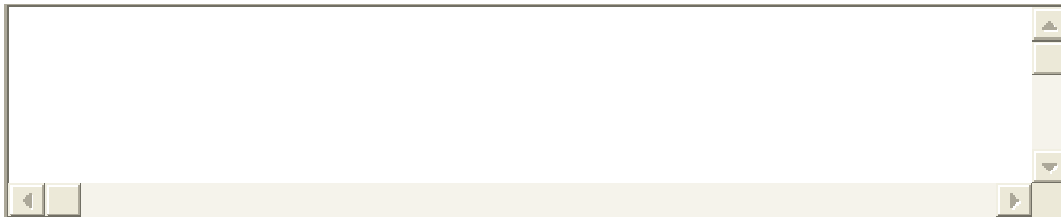
27. How have you publicised the results of the activities undertaken?



28. What effects if any, did publicising the results have? Please provide specific examples



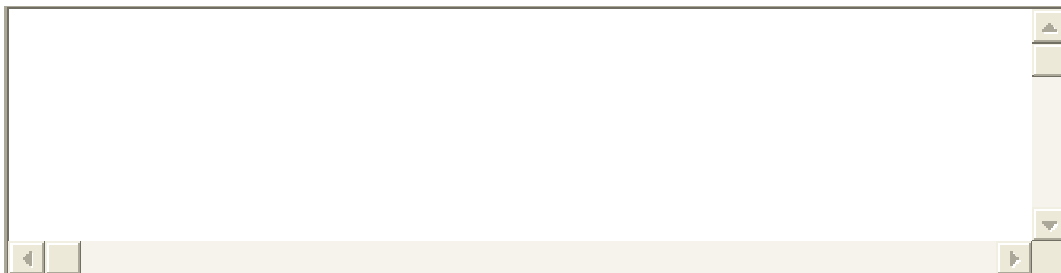
29. Have any models or courses been established in Cross-disciplinary research that could be attributed to the 'Bridging the Gaps' award? If yes, please provide details



30. How many people have benefited from 'Bridging the Gaps' award?

- 0-25 26-50 51-75 +100
 Other (please specify):

31. Which areas of Cross-disciplinary research have proved to be most fruitful? Was this planned?



32. Has 'Bridging the Gaps' had an impact on the amount of Cross-disciplinary proposals being submitted? If yes, please provide details

33. What has 'Bridging the Gaps' award enabled you to do that would not be possible without the funding?

Future of 'Bridging the Gaps'

34. Are you planning future activity beyond the end of the project?

- Yes, new project No, project is self contained No, would like to but can't continue Possibly
- Other (please specify):

35. Have you obtained any funding from the Institution to continue with activities within the remit of 'Bridging the Gaps'?

- Yes No, not needed No, still looking Yes, from external source
- Other (please specify):

General Lessons

36. Do you think 'Bridging the Gaps' scheme could act as a template for future mechanisms?

- Yes No Partly
- Other (please specify):

37. What elements of the 'Bridging the Gaps' scheme do you think were most successful?

38. Has your 'Bridging the Gaps' award evolved during the lifetime of the scheme? If yes, how?

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39. What lessons have you learnt from the award that could be applied in the future?

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40. In what ways could 'Bridging the Gaps' be improved?

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41. Is there anything else you would like to comment on regarding 'Bridging the Gaps' scheme?

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Appendix 2
Online Survey 2

Online Surveys

Develop, launch and analyse Web-based surveys

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Engineering and Physical Sciences
Research Council

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6.1.1 Grant Details

Grant Details

1. PI Name

2. Bridging the Gaps Title *(Optional)*

Questionnaire

3. What attracted you to get involved with the 'Bridging the Gaps' scheme?

4. What do you hope to achieve from the 'Bridging the Gaps' award?

5. Are there any specific research areas you will be focusing on at the start of the scheme?

6. Which area of research do you envisage will be the most exciting interface?

7. What are your main objective(s) for 'Bridging the Gaps'?

8. How do you plan do bring people from across the institution together?

9. Will you be using any new innovative mechanisms to bring people together?If yes, please provide specific examples

10. What will be the general level of participants involved in Bridging the Gaps?

- Undergraduate PhD student Post Doc Early stage academics
 Senior academics
 Other (*please specify*):

11. Have you ever taken part in similar research grants before?

- Yes No Other

12. Has the institution stated that it is committed to this award and will support the scheme throughout its duration, providing additional support e.g. workload relief

13. What do you think the 'Bridging the Gaps' award will enable you to do that would not have been possible without this award?

14. In which way do you think the 'Bridging the Gaps' award will have an effect on the institution in the future?
(select all that apply)

- Producing new specialists in field Links with other disciplines forming
- Support networks forming New collaborations forming None
- Other (please specify):

15. How will you publicise the results of the activities that 'Bridging the Gaps' will fund?

16. What elements of 'Bridging the Gaps' do you envisage will be the most challenging?

17. Does your involvement in 'Bridging in Gaps' align with the mission, vision and values of your institution?

18. Is there anything else you would like to comment on regarding 'Bridging the Gaps' scheme?

Appendix 3
Questionnaire for Pro-Vice Chancellor



Engineering and Physical Sciences
Research Council

Miss Hannah McNeil
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Dear XXX

INSTITUTIONAL IMPACT OF BRIDGING THE GAPS SCHEME

I am writing to request your institution's input in to an activity EPSRC is undertaking this year in relation to the Bridging the Gaps Scheme. The Bridging the Gaps scheme is an exciting opportunity for institutions to initiate, nurture and sustain interactions between researchers across disciplines. Bridging the Gaps Calls has been supporting the development of collaborative research programmes crossing the mathematical sciences, ICT and engineering (in 2006 and 2007) and EPSRC's Mission Programmes (in 2008). In 2009 we expanded the remit of the call to encourage applications that bridge the gaps between engineering and physical sciences (EPS) and other non-EPS research areas. In particular, we welcomed proposals that include interfacing with the social sciences and/or arts and humanities.

The purpose of the evaluation is to assess the impact that the Bridging the Gaps (BTG) scheme has had on the cross-disciplinary culture at institutions while also reflecting on the current investment. The outcomes will be used as input to future programme strategy development and to enhance the operation of the scheme as appropriate. This review is currently underway and is being carried out by myself and colleagues at EPSRC.

As Bridging the Gap grants are institutional awards we would welcome your views on the scheme and it would be extremely helpful if you could take some time to address the following questions. We would like you, as the Pro-Vice Chancellor to complete the Questionnaire as this will provide us an insight into the senior management's perspective, an institutional perspective and a strategic overview of what impact 'Bridging the Gaps' has had. **It is important that where possible you support your views with data and examples, as this will provide reportable evidence on the impact of the Bridging the Gaps programme at an institutional level** beyond that of the actual grant holders.

Please take the time to complete this questionnaire as fully as you can by the deadline of 30th July 2010. An electronic copy of the questionnaire can be requested from Hannah McNeill (tel: 01793 44 4485; email: hannah.mcneil@epsrc), and completed questionnaires can be posted to Hannah McNeill, EPSRC, Polaris House, North Star Avenue, Swindon SN2 1ET. It is important that we gather evidence from you in order to fully assess the effectiveness of the scheme. Thank you in advance for taking the time to contribute to this review activity.

Please do not hesitate to contact me if there is anything you wish to discuss further.

Yours sincerely

Hannah McNeill

Complexity-NET Administrator

EXAMPLE OF PVC QUESTIONNAIRE

Name:

1. To what extent are you aware of the Bridging the Gaps programme, and how has this awareness come about?

2. What impact has the Bridging the Gaps award had on other academics within the same department, related discipline, and across the University? *(Please try to give specific examples)*

3. Are you aware of success (es) directly attributable to the Bridging the Gaps funding? And if yes, has this success led to further leverage of Cross Discipline Research? *(Please try to give specific examples)*

4. What impact has the Bridging the Gaps programme had on your University strategy? Do the research areas in which they fall influence your University's roadmap for future strategic investment?

5. Has any extra support been provided by the institution that goes beyond the normal level of support to the grant holders to achieve the specific objectives of the call, If yes, how often? And in what way through the specific scheme enablers of

- Flexibility to pursue their strategic direction
- Exploration of speculative research directions
- Freedom for key groups to worked responsively and proactively
- Encourage academics to pursue research supported by this award that is not normally available
- Allow world leading groups to retain key expertise and development of researchers

6. Has the University made available any resources to support the development of ideas arising from the Bridging the Gaps award?

7. Have the Bridging the Gap Grant holders kept you (in your role as Pro Vice Chancellor) informed of specific opportunities to exploit the programme objectives in ways that would not have been feasible with a standard research grant? If yes, how often? And in what way? *(Please try to give specific example against each of the scheme objectives which are given above).*

8. Has the Bridging the Gaps Grant funding made the University 'more visible' externally? E.g. other universities, related research fields or the general public? *(Can you give examples where this has happened; not traditional academic papers or presentations)*

9. Would you be interested in getting involved in similar schemes if the opportunity became available?

10. Are there any other points that you would like to raise in relation to the Bridging the Gaps scheme that have not be covered above?

Appendix 4

Questionnaire to Non-PIs

Example of Questionnaire to Non PI's

- 1) What were your reasons for being involved in the project?**

- 2) How far has 'Bridging the Gaps' encouraged you to think and work outside your own discipline?**

- 3) Has the award affected your career in a positive way? Why? (please provide specific examples)**

- 4) Will you be implementing any new practices/processes as a result of the Bridging the Gaps scheme? If yes, please provide specific examples**

- 5) Did you encounter any problems/issues during this project? If so, what were these? (please provide examples)**

- 6) Has the scheme helped you develop your knowledge in another research area?**

- 7) What has BTG award enabled you to do that would not be possible without the funding?**

- 8) What aspects of 'Bridging the Gaps' were most successful? Why?**

- 9) Would you be involved in a similar scheme to 'Bridging the Gaps' in the future?**

- 10) Overall, how would you describe you experience of 'Bridging the Gaps'**

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