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Interdisciplinarity

Survey Report for the Global Research Council 2016 Annual Meeting

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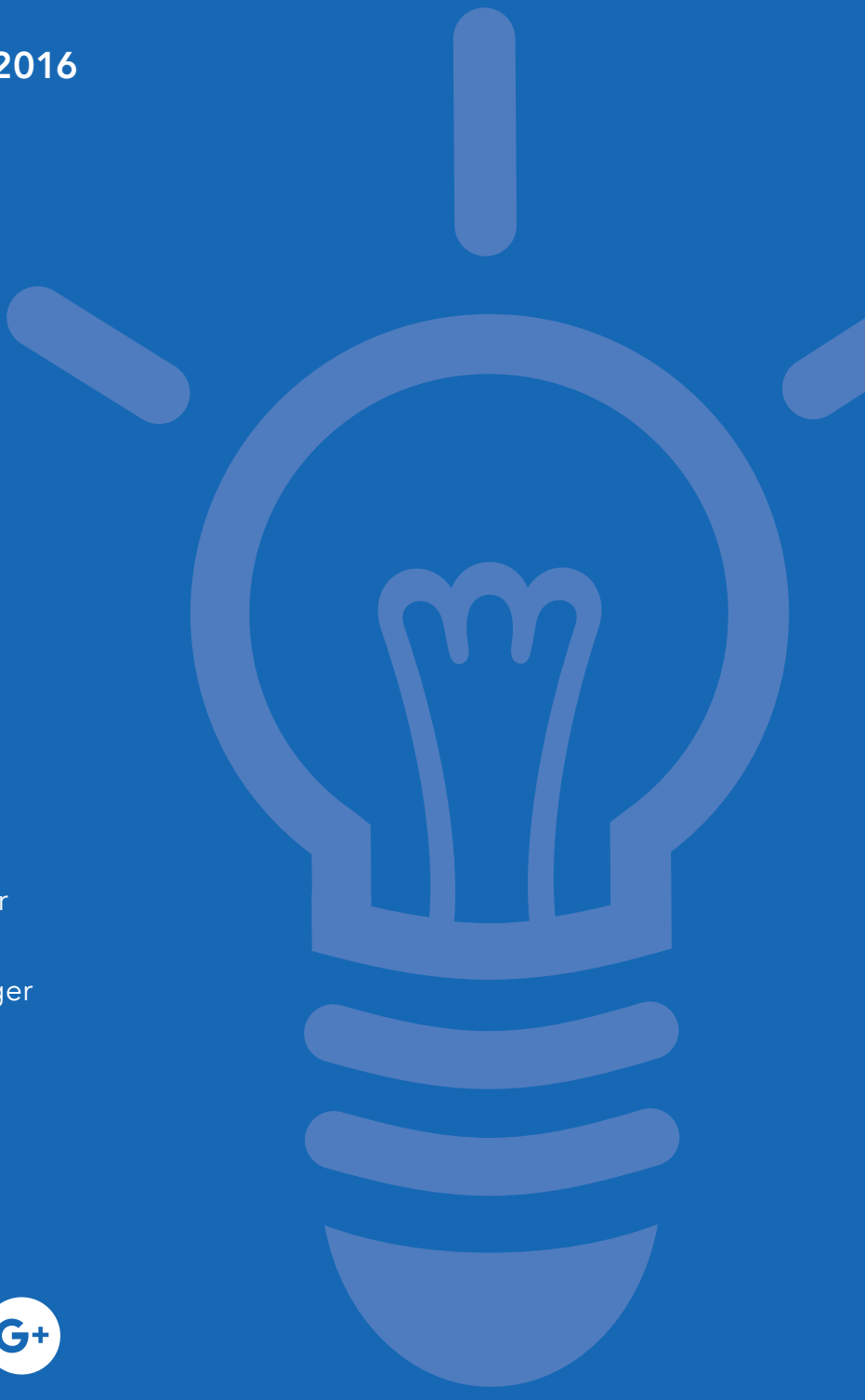

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Introduction

Below we provide a brief summary of the purpose of this report and the methodology used to prepare it.

At the Global Research Council's fourth Annual Meeting held in Tokyo in 2015, interdisciplinarity was endorsed as a discussion topic for the Annual Meeting in Delhi in May.

This report on interdisciplinarity was commissioned by both Research Councils UK (RCUK) and the Science and Engineering Research Board (SERB) on behalf of the Global Research Council. It has been prepared by DJS Research, an independent market research company, and is intended to act as a discussion paper for the GRC 2016 Annual Meeting.

For the purpose of this report we will simply define 'interdisciplinary research' as research where two or more disciplines work/join together to produce a common body of research.

The aim of the report is to provide an initial overview of what policies and policy environments exist globally amongst a small but balanced cross-section of GRC participants.

We recognise that many funding agencies may not have formalised policies for supporting interdisciplinarity. However, many have embedded what they consider to be good practice throughout their funding policies. The report aims to identify where and how this is happening and provide an initial assessment of success.

DJS conducted an extensive piece of desk research to assess the plethora of literature available on interdisciplinary research (IDR). Specifically, the desk research seeks to summarize the findings of diverse pieces of research, case studies, whitepapers and government policies that address funding agencies' roles, responsibilities and limitations in facilitating interdisciplinary research.

Alongside this, in-depth qualitative interviews were conducted with key decision makers and influencers at GRC members across the GRC regions, to provide case studies of how policies and good working practices have been implemented and adapted to ensure interdisciplinary research is supported and facilitated accordingly.

The remainder of this report is structured as follows:

1. Initially we provide an executive summary, which leads on to our recommendations.
2. We then provide a context-setting global overview of relevant studies and literature based on the desk research and literature review. We also contrast the literature with examples of policy and practice based on the in-depth 'case study' interviews with GRC members.
3. We conclude with a series of individual case studies summarising the policies, practices and experiences of the GRC participants that we interviewed.

Executive summary

The role and importance of IDR

Much of the global literature on interdisciplinarity argues that it has a key role to play in addressing the grand challenges that society faces. It is also suggested that funders can play a catalytic role in encouraging interdisciplinary research by setting and articulating such 'grand challenges' that require interdisciplinary solutions:

- Our research and much of the literature suggests that top down thematic funding programmes are one of the most common approaches adopted by funders to encourage interdisciplinarity.
- There is also a consensus that researcher led 'bottom up' approaches are required, and funding agencies should support such approaches despite the potential risks associated with the most innovative ideas.
- At the same time, interdisciplinary research should be viewed as a means to an end and not an end in itself. Several funding agencies emphasised that practices and policies towards interdisciplinarity should be driven by the required outcomes and scientific demand.

Establishing the right conditions for interdisciplinary working

There is widespread recognition that more needs to be considered than simply articulating the 'grand challenges' that require a research based solution. Interdisciplinary research can be complex and risky, and special consideration needs to be given to the 'architecture' of interdisciplinary programmes.

Whilst many of the funding agencies we spoke to have developed programmes based around themes that lend themselves to interdisciplinary approaches (and that often actively encourage them), developing effective structures to facilitate effective interdisciplinary working is something that many admit grappling with; practices are evolving, often in reaction to complex challenges, and in many cases informed by ongoing learnings about the barriers involved and how these can be addressed.

Much of the literature argues that funders should not assume that the conditions required for interdisciplinarity can happen naturally without proactive support; instead consideration should be given to the practical steps and mechanisms necessary to foster and support research across disciplinary boundaries:

- The increased complexity associated with interdisciplinary research means that appropriate timescales for funding are an important consideration. It is suggested that a 3-year funding timescale is counterproductive because in interdisciplinary projects, the start-up phase can last at least 2 years.
- Funders have the potential to fulfil a capacity-building role, for example using or facilitating training or infrastructure. Planning and implementation of interdisciplinary programmes should enable members to meet in order to exchange ideas, establish common terminology, build trust and understanding. This also extends to the design of physical and social spaces to foster the development of interdisciplinary networks and facilitate collaborative working across disciplines.

Assessment, evaluation & measurement

The establishment of fair and effective assessments of interdisciplinary research proposals is clearly a challenge for many of the funding agencies involved in the qualitative depth interviews; there is a strong consensus that there is a need to modify peer review procedures to ensure that they are better suited for IDR purposes.

Assessment approaches have been adapted in a number of ways amongst the funding agencies in our study; this includes the establishment of specialist panels composed of researchers from different fields; panels comprising of reviewers with multidisciplinary experience; flexible review processes where potential projects can be evaluated by more than one panel; two-tier screening processes comprising of an initial document review of the written application and a second panel review with panellists involved in both processes.

Many interviewed funding agencies admitted that even with adapted approaches, the review process remains challenging. This is partly due to a lack of reviewers who understand how to evaluate interdisciplinary research, and the related circular problem that there is a need to expose more reviewers to interdisciplinary projects. A number of funding agencies stated that the limited number of appropriate evaluators is leading to more extensive international collaboration to increase the pool.

End-of-award evaluation of interdisciplinary projects is perhaps an even bigger challenge. Most funding agencies interviewed admit that they have not established fully effective ways to evaluate the performance of interdisciplinary research. Again, practice is evolving and funders are learning from experience.

There is some recognition of a need to treat projects on a unique basis, look beyond 'standard' measures, employing project specific metrics and Key Performance Indicators (as well as qualitative assessment) to monitor performance against project specific goals.

Careers, training & recognition

Funding agencies should consider the role that they can play in promoting the value of interdisciplinary research, improving recognition, and ensuring that interdisciplinary researchers are not discouraged or disadvantaged. Some fundamental cultural challenges need to be considered:

- Many funding agencies interviewed recognized that there is work to be done to change the mind-set of researchers, to make them less risk averse towards interdisciplinary research.
- Disciplines are used to competing rather than collaborating, and finding leaders to establish and foster interdisciplinary relationships is considered a challenge.
- Although some feel that the situation may be gradually improving, interdisciplinary research is not seen with the same prestige as disciplinary research from a publication or academic career perspective.

The majority of funding agencies interviewed do not appear to have specific programmes or policies to foster training or infrastructure dedicated to interdisciplinary working, although in some countries there are specific research centres and facilities which are geared towards facilitating interdisciplinary collaboration. A minority of funders are also providing incentives for workshops and seminars across disciplinary borders.

There is potential for funders to play a greater role in developing and conducting interdisciplinary training and capacity building for both early stage and senior researchers. There is also an argument that training in IDR should be extended to funding agencies themselves, to improve understanding of its nuances and challenges.

Changing cultures and mind-sets is not an easy thing to do, and funding agencies should consider setting an example by promoting key success stories and the value of interdisciplinarity, and engaging with universities and publishers to work together on better recognition of and opportunities for interdisciplinary research.

Recommendations

1: Currently, informal practices that are evolving through trial and error are much more widespread than formal embedded policies towards interdisciplinarity. Increased sharing of experiences and best practice between GRC participants is one means of ensuring that funding policies to effectively support interdisciplinary working are developed.

2: GRC participants should be active in encouraging interdisciplinary research by setting and articulating top-down thematic 'grand challenges' that require interdisciplinary solutions, as well as supporting researcher led bottom-up approaches.

3: GRC participants should allow for funding support over sufficient timeframes for teams to organise, and at an appropriate scale to provide support to teams addressing the complexities of working across disciplinary boundaries.

4: GRC participants should work to encourage and facilitate the design of physical and social spaces to foster the development of interdisciplinary networks and facilitate working across disciplines.

5: GRC participants should consider how proposal review mechanisms can be adapted to ensure fair, relevant and appropriate approaches that are responsive to the purpose and potential impact of successful interdisciplinary research.

6: Adaptations and flexibility in end-of-award evaluation of grand challenge programmes should also be considered, employing project specific metrics and Key Performance Indicators (KPIs) as well as qualitative criteria to monitor performance against project specific goals.

7: GRC participants could do more to promote, help develop and conduct continuous training and capacity building for researchers and institutions, around designing and reviewing proposals for funding and evaluating the impact of interdisciplinary research. Support for training in leadership, communication and management skills should also be offered to increase capacity and capability in IDR.

8: GRC participants should actively work towards contributing to improved awareness of the value and necessity of interdisciplinary research, promoting key success stories and the value of interdisciplinarity, and engaging with policy makers, universities and publishers to work together on better recognition of and opportunities for interdisciplinary research.

Setting the context

The following section provides a context-setting global overview of relevant studies and literature, based on our desk research and literature review. We also contrast the literature with examples of actual policy and practice based on the in-depth 'case study' interviews with GRC members.

The role of IDR

There is a wealth of literature arguing the important role interdisciplinary research has to play, particularly in addressing complex and societal challenges.

In its response to the British Academy's call for evidence on interdisciplinarity (2015, p.1), The Royal Society argues the following:
"Many of the major challenges that society faces today will require solutions developed through interdisciplinary research and cross-disciplinary collaboration. Improving support for and addressing the barriers to this work could contribute to major scientific breakthroughs at the interface of disciplines, develop new technologies and ultimately support the economy and develop novel solutions to societal challenges."[i]

Top-down vs. bottom-up structures

It is widely recognised that appropriate funding programs and vehicles can be designed to encourage interdisciplinary research, depending on their criteria and objectives.

For example, a European Commission sponsored study of interdisciplinary research policies and practices across eight countries identified that policy and practice aimed at interdisciplinary research often has a 'top down', thematic approach.[ii]

Lyall et al. (2011, p.44) state the following regarding the role of funding agencies:

'Funders play a critical role in stimulating interdisciplinary initiatives. Ideally…the number of programmes that mandate interdisciplinarity would grow, particularly as complex problems become more pressing (as in the case of many environmental issues).

This entails funders identifying a focus which needs an interdisciplinary approach in order to be tackled effectively and asking questions that require individuals to work together across disciplines. Funders can play a truly catalytic role, for instance when problems are just beginning to coalesce.[iii]

Whilst this 'top-down' approach to interdisciplinary research will allow for structure and a common theme of evaluation, it is felt that there is a need to account for and encourage 'bottom-up' approaches as well.

In a report for the Australian Council of Learned Academies, Bammer (2012, p22) describes several methods for encouraging 'bottom-up' approaches, including:

- *'Setting aside a proportion of funding for interdisciplinary research bringing together science, technology, engineering and mathematics on the one hand and the humanities and social sciences on the other.*
- *Supporting permanent teams to investigate completely new interdisciplinary science such as artificial photosynthesis and biological computers.*
- *Making untied funding available to young researchers to allow them pursue 'wild' ideas.*
- *Funding an exploratory development phase for interdisciplinary research, preceding a full formal grant application.'*[iv]

There is an extensive body of literature which reinforces the argument that identifying questions that require interdisciplinary approaches in order to be tackled effectively is a key means by which funding agencies can drive interdisciplinary research.

At the same time, there is recognition that the more innovative 'grand challenge' research problems carry a perceived risk. However, some commentators argue that a policy of 'playing it safe' is likely to stifle innovation.

Blackwell et al (2009, p.54) note that:
'It may be the case that measures taken to reduce risk of project failure increase the risk of innovation failure, through sponsoring projects that are insufficiently innovative or adventurous. This is a constant concern of public agencies, which are obliged to 'play it safe' in their stewardship of public funds, desiring to make every project a success. Ironically, this can be the worst possible use of public funds, if careful stewardship by a funding agency prevents the creative innovations that justified a funding programme in the first place.'[v]

Funding Agency Perspective

Most of the funding agencies we interviewed were open in stating that they do not have formal policies relating to interdisciplinarity, but do have practices to encourage and support it. While the National Science Foundation (NSF) in the USA has specific policy for interdisciplinary research in place, the European Research Council (ERC) in Europe and the Australian Research Council (ARC) for instance are both in the process of formalizing relevant policies.

The most commonly cited practice is the establishment of funding programs that set the grand challenges that require interdisciplinary solutions. These schemes often lend themselves to interdisciplinary approaches, and in many cases actively encourage them.

The 'Challenges' vehicle at the Ministry of Business, Innovation and Employment (MBIE) in New Zealand and the Deutsche Forschungsgesellschaft's (DFG) Coordinated Programs in Germany as well as the NSF program Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE) are examples of such 'top-down' approaches.

A number of the funding agencies that we interviewed did stress that interdisciplinarity should be a means to an end and not an end in itself, however. It was suggested that practices and policies towards interdisciplinarity should be driven by the required outcomes and scientific demand.

One consequence of the 'top down' approach is that in many instances the approach to interdisciplinarity appears to be evolving, often in reaction to the need to meet complex challenges, and in many cases informed by ongoing learnings about the barriers involved and how these can be addressed.

Establishing the right conditions for interdisciplinary working

Top-down and bottom-up approaches may have potential to drive interdisciplinarity and in turn innovation; however, there is more to be considered than the question of 'grand challenges' that requires research based solutions. Special consideration needs to be given to how these types of funding programmes and vehicles are designed. Lyall et al. (2013, p.2) describe some of the considerations around the 'architecture' of interdisciplinary programmes as follows:

'This may lead to the launch of new funding schemes where they have a role in establishing the architecture of an interdisciplinary programme through, for example, the choice of leader, location, streams of funding, and mechanisms for accountability by establishing appropriate evaluation processes at various levels. Funders will often fulfil a research capacity-building function by providing additional training or infrastructure. All of these aspects may combine to facilitate the emergence of longer term impacts from the research that they have funded.'[vi]

Funding agencies have a pivotal role to play in supporting interdisciplinary research and it has been argued that agencies need to develop specific funding vehicles and mechanisms to encourage and facilitate interdisciplinarity.

Adunmo et al (2013, p.7) suggest a need for *'increased flexibility in funding frameworks, preparatory and pilot projects for overcoming disciplinary biases, sufficiently long timeframes, sustained support – especially when requesting impact measures – and, for multiannual, multi-programme frameworks, a substantial margin for new developments should be factored in'.*[vii]

Appropriate timescales

According to much of the literature, the increased complexity associated with interdisciplinary research means that appropriate timescales for funding are an important consideration.

In their 'Short Guide for Funders of Interdisciplinary Research', Marsden et al. (2011, p.2) suggest that researchers often see an inherent risk with the additional time and effort required to develop effective interdisciplinary teams and the possibility that this may discourage funders to invest: *'individuals do not want to be penalised for proposing interdisciplinary approaches which, by definition, are unconventional to individuals ensconced firmly in disciplines.'*[viii]

This is supported further by Straub and Schedlowski (2009), who argue that the start-up phase of interdisciplinary projects lasts at least 2 years, rendering the usual 3-year funding for single discipline projects counterproductive.'[ix] *'If we want to see interdisciplinary working in high-profile journals'*, write Straub and Schedlowski (2009, p.32), *'the funding period must be extended to 5 years'.*[x]

In addition, Lyall et al (2011, p.44) suggest that the interdisciplinary integration process needs to be facilitated by support opportunities for interaction throughout the course of the grant, which *'may require additional funding and time for integrative activities and personnel'.*[xi]

Community & capacity building

Much of the literature also recognises that funders have the potential to fulfil a capacity-building role, for example using or facilitating training and infrastructure.

Lyall et al. (2013, p.10) warn against making the assumption that the conditions required for interdisciplinarity can happen naturally without proactive support: *'There is often a tendency to assume that networking, community – and capacity-building will automatically occur as a result of participating in a research programme, in contrast to a more deliberative and reflective approach to achieving these ends. However, there are key practical organisational steps that large scale interdisciplinary research initiatives can take to promote and support collaborative working and integration. Pro-active management is crucial throughout an interdisciplinary initiative in order to achieve genuine interdisciplinary integration.'* [xii]

Bammer (2012, p.22) argues that team-based interdisciplinary research *'requires basic support to enable members to meet in order to exchange ideas, negotiate epistemological differences, establish common terminology and build trust – what some called 'glue money'. Different kinds of teams require different amounts of support, depending on size, diversity, the kind of problem being addressed and so on.'* [xiii]

In a German paper, Straub and Schedlowski (2009, p.33) highlight that facilities are also an important consideration:
'In joint projects the aspect of the Core Facility for providing techniques should be brought even more into focus. For this purpose, the subsidized university should be offering cross-disciplinary core facilities which remain in place for a period of at least 10 years. As part of the funding of a joint research project at a university these Core Facilities should be a central element of the funding, so that the intra-disciplinary facilities offered by the university can be secured and kept up to date (this applies to the personnel structure as well as to the technical equipment)'. [xiv]

Dzeng (2013) also writes that a key aspect to achieving interdisciplinarity is through the design of physical and social spaces to foster the development of interdisciplinary networks:
'Creating spaces where people continuously come into contact with people outside their discipline in natural, casual social settings over and over again, helps develop social networks that eventually become the source of intellectual inspiration and creativity'. [xv]

In their paper on the challenges of funding interdisciplinary research, Thomas König and Michael E. Gorman (2015, p.9) highlight a specific example from the United States, where
'the National Science Foundation funds research centres that tackle initiatives too large for one or even several investigators; these centers often are interdisciplinary. The "Integrated Graduate Education and Training" award was designed to give graduate students integrated training across research programs from different disciplines or sub-disciplines; this program has been replaced by an "Integrated Research Experience" solicitation, which could be either disciplinary or interdisciplinary'. [xvi]

Assessment, evaluation & measurement

The sheer volume of papers on peer review implies that this is a key concern for interdisciplinary researchers and agencies seeking to establish fair assessments of interdisciplinary research proposals.

Research conducted by Luukkonen (2015, p.10) establishes that *'peer review remains the major mechanism for selecting funded projects even in schemes dedicated to ground-breaking research.'* [xvii]

Koenig and Gorman (2015, p.10) confirm that *'the most common decision-making principle adopted by funding agencies is the peer review, or 'merit review' as the NSF refers to it'.* [xviii]

In Luukkonen's research on peer review (2015, p.21), the following factors were identified as being conducive to the selection of ground-breaking ideas:

- *'generalist (often interdisciplinary) panels with panellists who have experience in evaluating ground-breaking ideas*
- *criteria emphasising the innovative and unconventional nature of the research to be funded*
- *requiring short essay-like vision or research idea papers rather than proper research plans, especially in the first stage but in many schemes overall*
- *emphasising both ideas and people or only people and their creativity and ability to conduct radically innovative research.'* [xix]

Critically, Luukkonen (2015, p.22) observes that the funding organisations assessed *'make a serious attempt to modify peer review procedures to ensure that they are better suited for the purpose.'* [xx]

Koenig and Gorman (2015, p.11) identify the three most sensitive aspects of operationalizing the peer review principle to be the *'criteria along which proposals are valued, the experts (peers) who are invited to do this valuation, and the way the ratings of the experts are channeled into a funding decision'* [xxi]. In their assessment of the ERC and the NSF), Koenig and Gorman (2015, p.12) conclude that *'both agencies rely mostly on review panels in their final decision-making'*, which are *'generally expected to provide more reliable and better ratings than reviewers and are also expected to do a better job at identifying interdisciplinary research.'* [xxii]

Luukonen (2015, p.7) raises key questions if peer review is used, in particular concerning the type of changes or modifications that the funding bodies have made to avoid a potential conservative or other bias. *'To what extent do they use panel reviews or do they use remote reviewers as a complement? Do they use specific means to ensure that the reviewers provide recommendations to fund unconventional proposals? Is consensus required, and what are the means to achieving a consensus?'* [xxiii]

Lyall et al. (2011, p.52) recommend the *'establishment of an interdisciplinary reviewers' college (consisting of individuals expert in a range of interdisciplinary areas) to address the common challenge of finding reviewers who are sympathetic to interdisciplinary research and understand how to evaluate it both rigorously and appropriately'.* [xxiv] Indeed, the understanding is that *'until a certain level of interdisciplinary capacity is built, peer review represents a chicken and egg situation as interdisciplinary reviewers will only come about if there are successful interdisciplinary scientists who become reviewers.'* (p.45)

On a practical note, Marsden et al. (2011, p.3) suggest the following in considering the composition and management of review processes:

- Training for funding agency programme staff, so that they are more able to deal with such issues and to distinguish genuine interdisciplinarity
- Alignment of goals and criteria as stated in calls for proposals, with instructions for reviewers and panels
- Including individuals experienced in interdisciplinarity as panel members
- Take time at the beginning of a panel meeting to develop common understanding of the programme and criteria by which interdisciplinary bids are to be judged [xxv]

Funding Agency Perspective

Assessment, evaluation and measurement of interdisciplinary research is one area that many of the funding agencies we interviewed admitted grappling with, and an area that is evolving to cope with the challenges involved.

Assessment approaches have been adapted in a number of ways, including the establishment of specialist panels composed of researchers from different fields; panels comprising of reviewers with multidisciplinary experience; flexible review processes where potential projects can be evaluated by more than one panel; two-tier screening processes comprising of an initial document review of the written application and a second panel review with panellists involved in both processes.

Many funding agencies admitted that even with adapted approaches, the review process remains challenging – partly due to a lack of reviewers generally, and also due to a circular problem that there is a need to expose more reviewers to interdisciplinary projects.

Interestingly, a number of funding agencies (e.g. Consejo Nacional de Ciencia y Tecnologia (CONACYT) in Mexico, the Ministry of Business, Innovation and Employment (MBIE) in New Zealand, the Office of Sponsored Research (OSR) at King Abdullah University of Science & Technology (KAUST) in Saudi Arabia) stated that the limited pool of evaluators is leading to increased international collaboration to increase the pool.

In contrast to the considerable volume of literature on peer review and assessment of interdisciplinary research proposals, far fewer papers were identified that assess funding agencies' approaches evaluating the performance of interdisciplinary research.

Lyall et al. (2011, p.45) write extensively on the issue, concluding that *'end-of-award evaluation of interdisciplinary large-scale investments needs to be appropriate'*. Furthermore, they highlight that, *'while strong publications will be sought as measures of academic rigor, other less tangible indicators might suggest that added value from the interdisciplinarity is (or is not) being achieved.'* [xxvi]

Blackwell et al. (2009, p.83) concur with this view, recommending that *'funders of interdisciplinary activity need to move beyond a narrow focus on instrumental outcomes, and broaden their palette of metrics devoting more resources to capturing informal as well as formal outcomes, across a spectrum of outcomes, capacity and processes.'* [xvii]

Funding Agency Perspective

Most funding agencies admit that they have not established fully effective ways to evaluate the performance of interdisciplinary research.

Again, practice is evolving and agencies are learning from experience. There is some recognition of a need to treat projects on a unique basis, and look beyond 'standard' measures (e.g. of publication/citation).

Some funding programmes employ project specific metrics and KPIs to monitor performance against specific goals (e.g. MBIE in New Zealand). The NSF have advisory committees to review programmes and conduct external evaluations.

Careers, training & recognition

A further consideration for funding agencies is the role that they can play in promoting the value of interdisciplinary research, improving recognition, and ensuring that interdisciplinary researchers are not discouraged or disadvantaged.

Changing culture & mind-sets

A recently published book, Rethinking Interdisciplinarity Across The Social Sciences And Neurosciences (2015), suggests *'less focus on structures and funding for interdisciplinarity, and more on the everyday highs and lows of collaboration.'*[xxviii]

The authors argue the importance of recognising that the challenges of interdisciplinarity extend to the mind-sets and culture of the research community: *'What if the challenges of interdisciplinary work are less to do with obvious structural issues, and more to do with fuzzy, opaque zones of feelings, emotions and social interaction? … How would our understanding of – and capacity to improve – interdisciplinary research change if we focused less on funders and journals and universities, and more on the mundane, day-to-day lives of collaborative researchers?... This agenda isn't just about elegant structures and novel funding schemes, but about the day-to-day, here-and-now relations and feelings through which collaborative work gets done.'*[xxix]

The mind-set of researchers is frequently cited as a barrier to interdisciplinarity in the literature; the most common examples relate to the perceptions of risk associated with interdisciplinary projects, and the frequent allegation that researchers feel that single discipline publications are deemed more prestigious than those of an interdisciplinary nature.

Encouraging early career interdisciplinarity

The career paths within interdisciplinary research can be uncertain, and those researchers with the potential to work across multiple disciplines need to be given extra encouragement and support in order to play an integrative role.

A number of suggestions are put forward in the literature regarding the role funding agencies can play in ensuring that interdisciplinary researchers in the early stages of their career are not disadvantaged by rigid structures within departments or by publishing outlets.

Lyall et al. (2011, p.3) suggest *'facilitating the development of a cadre of early career and more senior interdisciplinary researchers by hosting community-building events across different interdisciplinary capacity-building schemes and investments. An Interdisciplinary Funders Forum similar to the Environmental Research Funders Forum (now part of LWEC) or the UK Strategic Forum for the Social Sciences could promote shared learning'.*[xxx]

Straub and Schedlowski (2009, p.33) suggest that *'research funders should ensure in collaborative projects that interdisciplinary teaching concepts are integrated (which is already required by the DFG of specific research areas). In addition, funders could also establish long-term interdisciplinary teaching concepts at the universities, which go beyond the usual funding period of a typical joint project….the increased stabilization of the interdisciplinary aspect in the universities should be reinforced with the opening of new career paths. Otherwise, the interdisciplinary route will stop at the disciplinary boundaries.'* [xxxi]

Careers & recognition

Beyond the training stage, the issue of career progression is also highlighted in the literature. In particular, it is suggested that research funding agencies should engage with universities and publishers to work together on better recognition of and opportunities for interdisciplinary research.

Marsden et al (2011, p.3) suggest that *'when considering career possibilities, funders need to be aware of the constraints imposed by universities, with the suggestion that Research Councils (and universities) provide more recognition for ECRs and PhDs who take on interdisciplinary work, urging that interdisciplinary researchers should never be considered 'second tier'.*[xxxii]

In addition to this, there is also the issue, highlighted by some commentators including Marzano et al (2006, p.9), that *'interdisciplinary publications were less prestigious than single discipline ones.'*[xxxiii] This is something which needs to be overcome in order to encourage more individual researchers to commence on, or continue down, the interdisciplinary route.

Similarly, Strang and McLeish (2015, p.4) suggest that *'There is a need to expand the range of outlets for academic publication that value and recognise high quality interdisciplinary research'.*[xxxiv]

These are perhaps some of the more challenging issues to address, emphasising that facilitating interdisciplinary research is not simply about asking the big questions that require an interdisciplinary approach, or the mechanisms and structures adopted. Issues for funding agencies to consider extend to capacity-building, developing knowledge and skills, facilitating networks and changing the mind-set of the research community.

Funding Agency Perspective

Most of the funding agencies interviewed recognized that there is work to be done to change the mind-set of researchers, to make them less risk averse towards interdisciplinary research. Disciplines are used to competing rather than collaborating, and finding leaders to establish and foster interdisciplinary relationships is also considered a challenge.

Some funding agencies also highlighted the related need to take steps to address the perception that interdisciplinary research is not seen with the same prestige as disciplinary research from a publication perspective.

The majority do not have specific programs or policies to foster training or infrastructure dedicated to interdisciplinary working, although in some countries there are specific research centers and facilities which are geared towards facilitating interdisciplinary collaboration.

There are exceptions – for example DFG in Germany works to facilitate interdisciplinary working by providing incentives for workshops and seminars across disciplinary borders.

Conclusions

The aim of this survey report is to provide an initial overview of what policies and policy environments exist on the issue of interdisciplinary research. The findings are based on a small but globally balanced cross-section of GRC participants.

Many of the funding agencies have developed programmes based around themes that lend themselves to interdisciplinary approaches. However, effective structures to facilitate effective interdisciplinary working is something that many admit grappling with. Indeed, practices are evolving, often in reaction to complex challenges, and in many cases informed by ongoing learnings about the barriers involved and how these can be addressed.

Our research suggests that top down thematic funding programmes are one of the most common approaches adopted by funders to encourage interdisciplinarity.

However, there is also a consensus that researcher led 'bottom up' approaches are required, and funding agencies should support such approaches despite the potential risks associated with the most innovative ideas.

At the same time, interdisciplinary research should be viewed as a means to an end and not an end in itself. Several funding agencies emphasised that practices and policies towards interdisciplinarity should be driven by the required outcomes and scientific demand.

The establishment of fair and effective assessments of interdisciplinary research proposals is a challenge for many funding agencies. Indeed, assessment approaches have been adapted in a number of ways, yet many funding agencies admitted that the review process remains challenging nevertheless, which is partly due to a lack of reviewers who understand how to evaluate interdisciplinary research.

End-of-award evaluation of interdisciplinary projects is perhaps an even bigger challenge, and most funding agencies admit that they have not established fully effective ways to evaluate the performance of interdisciplinary research.

Many funding agencies recognized that there is work to be done to change the mind-set of researchers, to make them less risk averse towards interdisciplinary research. Although some feel that the situation may be gradually improving, interdisciplinary research is not seen with the same prestige as disciplinary research from a publication or academic career perspective.

The majority of funding agencies do not appear to have specific programmes or policies to foster training or infrastructure dedicated to interdisciplinary working, although in some countries there are specific research centres and facilities which are geared towards facilitating interdisciplinary collaboration.

In short, informal practices that are evolving through trial and error are currently much more widespread amongst GRC participants than formal embedded policies towards interdisciplinarity.

Increased sharing of experiences and best practice between GRC participants is one means of ensuring that funding policies to effectively support interdisciplinary working are developed.

Case studies

Each case study included in this section of the report is based on a depth interview with a representative of the profiled funding agency. Furthermore, in some cases publically available information provided by the representative was also assessed when establishing key background and policy information for the case study.

In light of the fact that funding agencies' approaches to facilitating interdisciplinary research vary considerably, and are indeed dependent on political, economical and environmental factors within their geographical remit, the respective case studies do not always lend themselves to comparative analysis. Nevertheless, we have sought to structure the content of each case study such that key learnings from interdisciplinary research policy are immediately accessible.

Each case study follows the structure detailed below:

- Background to the funding agency
- Interdisciplinary Research – funding mechanisms and programs
- Challenges in establishing the right conditions for interdisciplinary research
- Key learnings for future policy deliberations

DJS Research, RCUK and the GRC would like to thank all those who participated in the research.

A list of participating GRC members is provided on the right.

Africa
NCST (Malawi)

Americas
NSF (USA)
CONACYT (Mexico)
Colciencias (Colombia)

Asia-Pacific
MBIE (New Zealand)
ARC (Australia)
DST (India)
JSPS (Japan)

Europe
MRC (UK)
DFG (Germany)
ERC (European Union)

MENA
OSR (Saudi-Arabia)
TAASTI (Tunisia)
QNRF (Qatar)

Background

The National Commission for Science and Technology advises the Government and other stakeholders on all science and technology matters in order to achieve a science and technology-led development.

The Commission charts out the national direction and establishes national priorities in science and technology development in relation to socio-economic development needs. Furthermore, the Commission sources funding from within and outside Malawi to finance the national research and development effort and allocates the funds to research institutions based on set priorities.

The government, on an annual basis, advances close to half a million dollars to the NCST and these funds are used for research in the country at the moment.

Interdisciplinary Research

The facilitation and appropriate funding of interdisciplinary research is seen as vital by NCST.

"We look at IDR as having the potential to be revolutionary, to find solutions to the issues our country is facing. We are going through difficult times, facing issues of climate change, draught, hunger, diseases, so we are trying to look at IDR as an avenue to address some of the challenges that we are having."

NCST has limited experience in promoting interdisciplinary research, but is seeking to create the right environment within which interdisciplinary research can be appropriately promoted.

"Basically we have not yet had any funding in interdisciplinary research, but we have had instances whereby some of the research that applicants are conducting has or may have some interdisciplinarity in it."

NCST funds research in accordance with national research agendas and encourages proposals in areas that have been identified as critical for the development of Malawi.

"Sometimes we get some applicants who have cross cutting issues; they submit proposals that are interdisciplinary in nature."

NCST does not have specific policies dedicated to interdisciplinary research, but applies policies from various research agendas to screen as well as evaluate proposals that are interdisciplinary in nature.

"Now that we have been exposed to issues of IDR, it is becoming more pertinent for policies to adjust and accommodate. We will have a review of the policies early next year."

Assessment, evaluation & measurement

Assessment

"Once we receive the research proposals we set up working groups or teams of individuals that would form the evaluation team and we ensure that the team has the background suited to deal with the application."

Panels

A main reviewer with expertise in the relevant area is appointed to work alongside reviewers from different backgrounds. Only in specific instances is a peer reviewer asked to be involved.

"In the event that the assembled team is not able to make their own recommendation or review of the proposal, we may refer the proposal further; maybe to invite other people who can assist in that area."

The panel that is assembled does not include members of NCST. Panel members are invited from academia, but also include public officials and government administrators.

Evaluation

Researchers and the NCST sign a contract which specifies the expectations from both sides. The agreement incorporates a number of issues, including when funds will be disbursed and in what amounts, as well as the deliverables at every stage.

"At each stage we expect a report on what has been achieved, before the next funds are disbursed."

"Normally there are about 3 to 4 stages, but it varies on the type and complexity of the research we are doing. Most projects are funded over two years."

"When it comes to IDR, we borrow what is available from the current system, but once the policies have been reworked, it is possible that we will have more stages for IDR."

Careers, training & recognition

NCST understands itself to have a key role to play in building capacity and training researchers in interdisciplinary thinking and cross-discipline collaboration.

"Granting councils have a big role to play. This is why we are here, and we would like to encourage multidisciplinary research. We facilitate and support research in the country, but perhaps we need to emphasise the need for support in IDR from proposal writing, but also grants, even including research methods."

International collaboration

"We have a number of agencies that we work with internationally. We announce anything that will provide an opportunity to Malawian researchers and will forward calls to various stakeholders in the country."

Challenges in establishing the right conditions for interdisciplinary research

Reviewers of the right calibre

"A fair review of an interdisciplinary research proposal is a challenge because sometimes individuals that we identify are only captains, but they may not be that familiar with something that is really cross cutting and requires knowledge in both areas."

Aligning insights from multiple reviewers

"To integrate concepts that arise from different disciplines or theories is a barrier. We struggle to link concepts from different investigators or reviewers."

Building capacity

"How do we bring together individuals from different backgrounds to understand tools, concepts, perspectives or theories from other disciplines to advance knowledge and create some solutions?"

Key learnings

- Top-down structures are important in order to identify priority issues and set the grand challenges that require interdisciplinary solutions. Research funding agencies should be actively involved in the articulation of challenges as well as the provision of funding for interdisciplinary research.
- IDR has a key role to play in addressing grand challenges and achieving societal impact.
- Relevant processes, including peer review and research quality and impact assessments need to allow for consideration and recognition of the nature of, and issues involved in, research across disciplinary boundaries.
- Funding agencies should promote, help develop and conduct continuous training and capacity building for researchers and institutions engaged in interdisciplinary research.

Background

The National Science Foundation (NSF) is an independent US government agency created in 1950 *"to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defence..."* The NSF has an annual budget of US$7.5 billion (2016) and is the funding source for almost a quarter of all federally supported basic research conducted by America's colleges and universities.

The Office of International Science and Engineering section (OISE) serves as a focal point for international science and engineering activities both inside and outside NSF[1].

Interdisciplinary Research

Interdisciplinary research is well-established across the entire Foundation, with many different mechanisms and specific policies for IDR.

The NSF has a unique awards programme dedicated to encouraging interdisciplinary research:

The Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE) is a cross-foundational awards program established in 2012/13 to 'support bold interdisciplinary projects in all NSF-supported areas of science, engineering and education research'.

INSPIRE awards up to US$1million grants to high risk, high reward interdisciplinary proposals.

Other cross-foundational initiatives often come about from interests in the community.

Current nationwide big initiative on food, energy, water nexus that came about from many earlier interdisciplinary programmes in the sustainability field.

"A few years back we had a big initiative on sustainability, and at its height there were seventeen different interdisciplinary proposals. Each of those programmes was managed by a cross-section of programme directors throughout the Foundation and the panels were very interdisciplinary."

Assessment, evaluation & measurement

Review system

INSPIRE proposals, like most NSF proposals, are researcher-led, or bottom-up.

Only internal merit review is required for INSPIRE proposals, but NSF Programme Officers may elect to obtain external reviews to inform their decision.

Co-review is very common in core programmes at NSF.

In applications answering specific calls for proposals, Principal Investigators (PIs) may indicate that the proposal should be co-reviewed with another programme.

Alternatively, Programme Directors may decide proposals lend themselves to be co-reviewed by another programme.

"There's a lot of [co-reviewing] that goes on day to day at NSF...Often when a PI submits a proposal they may not even realise that as Programme Directors we often look at it and go to other programmes and ask them if they would be interested in co-reviewing."

Each programme recommends reviewers from their field to review a proposal. Interdisciplinary proposals often go to two panels in two different programmes.

Panels make recommendations and Programme Directors decide which proposals to support. If both panels and both programme directors like a proposal, funding is negotiated between the two programmes.

Evaluation

NSF has an evaluation and assessment section, advisory committees to review programmes and also conduct external evaluations.

"One of the questions we always ask as a funding agency [for big cross-foundational initiatives] is 'is this funding needed or could this programme have been done through normal co-funding programmes?"

[1] *https://www.nsf.gov/od/oise/about.jsp*

Successful IDR programmes are often considered to be those that continue past their original term.

"Usually these cross-foundational initiatives have a set life and then we go onto something else, but that [successful project] was something that people around the Foundation saw a need to continue."

Careers, training & recognition

Education is seen as key at NSF, and it is important to allow opportunities for early career researchers to get involved in IDR.

"We often hear from young researchers that it is very hard [to get IDR published] because they have to prove themselves in their field first. More senior researchers have a little bit more freedom."

Funding agencies should play a role in encouraging academic institutions to support IDR.

Capacity building

Larger awards are strongly encouraged to have an assessment component, a specific co-ordinator and an advisory committee from the outset.

International collaboration

OISE conduct many international IDR programmes, and have a specific programme, Partnerships for International Research and Education (PIRE), to support international activities across all NSF supported disciplines.

PIRE programmes often lend themselves more to IDR than standard programmes.

Over a dozen countries joined from across the world in recent solicitations – if a project gets funded each country supports its own researchers.

Challenges in establishing the right conditions for interdisciplinary research

Interdisciplinary proposals can review badly at panel review

The INSPIRE program is intended to address more complicated scientific problems and encourages proposals that may be considered to be at a disadvantage in a standard NSF review process.

Differing perspectives on interdisciplinarity

Researchers can be protective of their core discipline and do not always agree that an IDR proposal sits totally within their field.

"I think sometimes people are very conservative, especially when budgets are tight. 'Why are we supporting this that has to do with Social Science' and then Social Sciences will say 'Why doesn't Geoscience support this'?"

True integration of the team

"You can't just put a social scientist on your proposal so that you check that box. They need to be really integrated into the actual proposal and the project. It's hard to do that right."

Key learnings

- IDR plays a key role in addressing high risk, transformative research problems, and funding agencies must accept the inherent risk of failure.
- Researcher-led approaches to interdisciplinary research continue to require funding agency support, and can themselves identify transformative 'grand challenges'.
- Funding agencies need to implement specific systems, practices and mechanisms to truly facilitate interdisciplinary research.
- A cultural shift in the mind-set is required to promote interdisciplinarity both within the research ecosystem, and within academia.
- Interdisciplinary researchers in their early career stage should be encouraged to conduct IDR and not be disadvantaged by departmental or publication structures.

Consejo Nacional de Ciencia y Tecnología (CONACYT)

Background

The National Council on Science and Technology (CONACYT) is Mexico's entity in charge of the promotion of scientific and technological activities, setting government policies for these matters, and granting scholarships for postgraduate studies.

Interdisciplinary Research

While CONACYT has not defined a policy for interdisciplinary research, but considers itself to be 'reacting to a new situation and defining policies as we move along', it has two specific calls for proposals of an interdisciplinary nature, as well as a call for basic research which accepts multidisciplinary research proposals:

Scientific Development Projects to Address National Problems

The grant was launched in 2013 to deal with social challenges, with an annual budget of US$21 million.

Research Thematic Networks

It was established in 2009, and funded 51 networks in 2015, providing single year grants, with a budget of US$8 million for scientific collaboration with networks to address strategic areas.

"We consider that the network must have contact with other disciplines in order to address problem solutions."

A small proportion of projects that come in under the **call for basic research** fall into the category of multidisciplinary research, accounting for maybe 10 percent of the total budget of US$38.5 million.

Assessment, evaluation & measurement

Review system

CONACYT has a special panel composed of scientists from different fields and with multidisciplinary experience.

Agreements with Spain, Colombia & Chile are in place to enable access to a wider pool of evaluators.

"We're working along with some other countries to create what we're calling a bank of Ibero-American evaluators."

The national pool of evaluators is not big enough so there is a risk of the evaluator knowing the researcher proposing the project, creating a conflict of interest.

"We try to overcome that by internationalising."

Evaluation

A researcher's practical experience in working with other disciplines is evaluated.

Specific criteria have been developed to evaluate interdisciplinary projects, including the coalition of the members of the project, as well as the proposed working processes.

"They have to demonstrate that the different disciplines work together and not apart, before finding ways to put the puzzle together at the end. We want the puzzle to be exposed from the very beginning."

Proposals must demonstrate how social & economic impact will be achieved.

Performance monitoring

Research projects are funded for 2, 3 or 4 years and funding recipients must submit an annual progress report to ensure the next allocation of funding.

Report evaluation ensures that the project is on target to achieve the objectives.

If doubts arise about the annual report, it is sent to reviewers for further consideration.

Biblio-metrics are not officially used as a tool to analyse or evaluate the contributions from the different disciplines that are involved in interdisciplinary projects. Published papers are the main product to evaluate interdisciplinary projects.

Careers, training & recognition

Capacity building

CONACYT has not implemented a specific policy to promote graduate interdisciplinary programmes.

"So far, the need for interdisciplinary human capital has not been translated into a policy to promote graduate programmes of that kind."

"On the whole, research institutions are not ready to receive students with an interdisciplinary profile."

International collaboration

Mexican scientists & researchers participate in international projects, but few of those are of an interdisciplinary nature.

"We would be open to international invitations to do interdisciplinary work, but so far that has not been very frequent."

Challenges in establishing the right conditions for interdisciplinary research

Defining interdisciplinary research

"We see a lot of interdisciplinary projects that are not really interdisciplinary; in the category of interdisciplinary."

The ability to distinguish between what is and what is not interdisciplinary research is crucial in order to ensure appropriate evaluation.

Lack of information to guide appropriate policies

"We are entering new ground in many ways so we do not have available databases to guide our policies. We have to break new ground and over time there will be more and more information, and it will be easier to make comparisons across projects to compare impact."

Incentivising interdisciplinary research

Researchers consider publishing in scientific journals as being productive.

Interdisciplinary projects will need new journals to lead to publishing.

"What we as the funding agency and the policy of the funding agency have to do is work very hard with the Mexican scientific community to change that attitude so that they accept interdisciplinary work as valuable and legitimate research."

Key learnings

- Interdisciplinary research has a key role to play in addressing grand challenges and achieving societal impact.
- Research funding agencies should find ways to encourage research across disciplinary boundaries, including by developing and implementing networks between science and industry.
- Agencies should seek to develop a more encompassing definition of both disciplinary and interdisciplinary research as there is a need for research funding agencies to better understand the nuances involved in interdisciplinary research.
- Research funding agencies should engage with publishers to work together on better recognition of and opportunities for interdisciplinary research.

Background

Colciencias is a Colombian government agency that supports fundamental and applied research in Colombia. Colciencias is a public entity that leads, directs and coordinates the national policy for Science, Technology and Innovation in order to generate and integrate knowledge to help to develop the social, economic, cultural and territorial development of Colombia and improve the welfare of Colombians.

Securing funding

Research funding is particularly low this year, and a fund of between US$25-30 million will be made available for Science, Technology and Innovation research.

Interdisciplinary Research

Colciencias is very engaged with interdisciplinary collaboration and is working hard to promote interdisciplinary research but this approach is not well developed within Colombia.

In previous years, very few calls for proposals have proposed interdisciplinary research – the only visible interdisciplinary research conducted in Colombia at this stage is through some of the Centers of Excellence for Research.

Centers of Excellence for Research are national networks of research groups in Colombia that pursue common problems in a scientific and technological area of national strategic importance. The centers are part of the national public policy for the promotion of research through the creation or strengthening of the national research programs in complex and priority subjects, that require interdisciplinary, and interinstitutional, intersectoral, and international collaboration. The centers are funded by Colciencias and the participating universities and institutions.

A move towards interdisciplinary research

Three 'grand challenges' for Colombia this year are:
- Peace construction
- Green growing
- Adding value to natural/ non-renewable resources

Grand challenges must transverse different disciplines

"The team here at Colciencias are all very convinced that interdisciplinary research is a condition required for really generating impact of all the national systems of Science, Technology and Innovation, and with traditionally uni-disciplinary research we could not advance in the way that is necessary."

Moving the funding focus away from single disciplines

Funding has traditionally been only given to single disciplinary research: funding in previous years has been divided between the different disciplines/programmes, e.g. 10% Health, 50% Basic Science.

A new approach this year seeks to promote more interdisciplinary research through the allocation of a global budget rather than programme-specific budget.

Careers, training & recognition

Publishing IDR

Due to lack of interdisciplinary journals in Colombia, it is difficult to publish the results of interdisciplinary research.

"To put it in one journal, the social contributions will not help with the evaluation of the paper but if you put it in a social sciences journal all the engineering work would be misunderstood."

International collaboration

There is no real international interdisciplinary research conducted in Colombia at present.

Colciencias is in the very early stages of working with the Ministry of Education in building an ambitious programme for creating international partnerships with universities that would involve interdisciplinary research.

Challenges in establishing the right conditions for interdisciplinary research

Breaking tradition

There is a very traditional research community in Colombia that is resistant to interdisciplinary working.

"It's not easy because people in research traditionally are very closed to their own discipline, so we are trying to force the system on that."

Negotiations between disciplines

Negotiations when working with different alliances within the same discipline have proved problematic.

Negotiating between different disciplines, each with its own methodology, is a difficult and slow process.

"Usually they work alone in a single way, so making this approach requires many things... different methodologies and products in the different disciplines, and even different timescales, this is a negotiation that our groups are not in the habit of doing."

No formal policy

No formal interdisciplinary policy within Colombia leads not only to no specific funding but a lack of constant or continuous lines of work on interdisciplinary research.

"We don't have specific funding for [interdisciplinary research]."

The national policy document, CONPES (not specific to Science and Technology) is currently under discussion, and will have an orientation towards interdisciplinary research and will facilitate interdisciplinary research going forward.

Key learnings

- Interdisciplinary research is necessary for development, and in particular for addressing grand challenges.
- Interdisciplinary research requires time to form appropriate partnerships, and to allow for negotiations between alliances.
- Research funding agencies should be prepared to support interdisciplinary teams, and need to construct clear policies and systems in order to attract single disciplines to collaborate with others.
- Research funding agencies should actively promote the value and necessity of interdisciplinary research, and help to develop a shift in mind-set towards interdisciplinary research.
- Research funding agencies should engage with publishers to increase recognition of and opportunities for interdisciplinary research.

Background

The Ministry of Business, Innovation and Employment (MBIE) is responsible for the government funding into science in New Zealand.

MBIE oversees a range of different types of government investments, including contestable, negotiated and institutional expenditures.

Interdisciplinary Research

The National Science Challenges are part of MBIE's negotiated expenditures, and a portion of contestable funding has been redeployed to support the Challenges – a funding vehicle for interdisciplinary research.

The National Science Challenges have provided funding to New Zealand researchers since 2013 to tackle some of the biggest science-based issues and opportunities facing New Zealand.

The eleven National Science Challenges were identified through:

- A consultation, involving a TV advertisement to engage the public.
- A series of workshops run with the science sector.
- Analysis and prioritisation by an independent panel chaired by the Prime Minister's Chief Science Advisor.

The National Science Challenges makes a fund of some US$820 million available over a 10 year period. Applicants submit a research and business plan for up to 10 years, as well as a work programme for an initial period of up to five years. Towards the end of the first funding period, Challenge collaborations must submit a further detailed work programme for the next five years.

Reason for this approach...

The National Science Challenges are mission-led investments that focus on issues of national importance. Each Challenge encourages proposals from New Zealand's 'best team' and looks for additionality.

Researchers in the relevant areas of science were encouraged to form collaborations to put forward a joint proposal which needed to demonstrate how, over time, new capability, research, and researchers would be introduced into the Challenge through a contestable process.

Universities, CRIs and other research providers have formed consortia of the best teams to present proposals:

"We were looking for what we were calling a multidisciplinary approach. We wanted to specifically incentivise different disciplines to come together to really make a step change in the science being done to address each challenge."

Assessment, evaluation & measurement

Review system

Independent panel assessment (IAP) before going to the Science Board for decision-making.

IAP of international and New Zealand experts in the relevant areas.

"We actually had to bring in international science experts because seeking the best New Zealand team meant that everyone was conscripted in New Zealand."

People chairing the panels tended to chair more than one to give continuity across the challenges.

The same panel reconvened in cases where the proposal came back.

"We wanted them to be the best New Zealand team, bringing different disciplines into the best New Zealand team, which meant that we were actually only looking for one proposal for each of the challenges."

Performance monitoring

A framework to measure and monitor performance and to be used by all Challenges, including common metrics, e.g. numbers of publications.

Ensures the ability to collect consistent information and monitor how the policy is performing.

The framework also allows for each of the challenges to create their own metrics & KPIs to monitor performance against specific goals.

There is an MBIE observer on Challenge governance entities.

There is a review of all Challenges after five years to determine funding for the next five years.

Careers, training & recognition

MBIE does not currently foster training in interdisciplinarity through specific programmes, but considers this an issue for funders to think about.

Challenges in establishing the right conditions for interdisciplinary research

Changing scientists' mind set of competition

"They're used to competing with each other. They're not used to putting their ideas on a table. Getting the right proposal was really hard."

Leadership

"We have struggled in New Zealand to find eleven leaders. Independent people who are focused on the outcome of the challenge and not on the institutional funding. The leadership is absolutely critical and getting somebody who's got that science credibility but also can work the relationships."

Governance

"We're actually devolving the funding to the challenge for them to make decisions. We're keen to make sure there are independent people on those governance groups rather than representatives of the research organisations who are just going to carve up the money amongst themselves."

Key learnings

- Top-down structures are important in order to identify priority issues and set the grand challenges that require interdisciplinary solutions.
- Funding agencies have a key role to play in facilitating interdisciplinary working by developing systems and practices that accommodate interdisciplinarity.
- Particular effort should be invested in the development of common as well as project specific metrics to enable performance assessment of interdisciplinary policy.

Background

The Australian Research Council (ARC) is a Commonwealth entity and advises the Australian Government on research matters, administers the National Competitive Grants Programme, a significant component of Australia's investment in research, and evaluates the quality of research.

The ARC's mission is to deliver policy and programmes that advance Australian research and innovation globally and benefit the community.

Interdisciplinary Research

The ARC funds interdisciplinary research across the range of its funding programmes. The ARC is currently developing a policy on interdisciplinary research and looking at ways to better identify and assess it.

The ARC's support for interdisciplinary research ranges from pure research through to applied research.

"The ARC supports a range of interdisciplinary activity, ranging from an individual researcher using a methodology from outside their discipline area to different disciplines working together to solve a complex problem."

The ARC is currently developing a formal policy around interdisciplinary research.

"We are developing a new policy and a new framework around interdisciplinary research, looking at ways of better tracking interdisciplinary activity, and enhancing ways of assessing and supporting it."

Assessment, evaluation & measurement

Identification

Up until recently, interdisciplinary research was identified by the combination of non-cognate fields of research codes, or codes that go across major discipline areas. From December 2015, the ARC has asked applicants to identify if the research is interdisciplinary, to understand the scope of interdisciplinary research and to better inform its policy.

The ARC is investigating how to assess interdisciplinary research differently in the future, using a *"more nuanced understanding of interdisciplinary."*

The ARC has not defined interdisciplinary research but has identified that interdisciplinary research may include:

1. Researchers from different disciplines working together in a team.
2. Researchers collaborating to bring different perspectives to solve a problem.
3. A researcher or researchers utilising methods normally associated with one discipline to solve the problems of another
4. Researchers developing innovative cross-disciplinary methodologies to address a research problem.

Assessment

The ARC is currently considering the best way it can assess interdisciplinary proposals in the future. This might include assessors with a background in interdisciplinary research or assessors from a mix of relevant disciplines. The ARC will also consider how to provide guidance to assessors to assist in assessing interdisciplinary proposals.

"The ARC believes that any methodology to assess interdisciplinary research must result in the best quality research being funded."

A possible assessment model

An interdisciplinary application will be assigned to at least one member of the ARC College of Experts who has *"the right interdisciplinary mix for the application."*

The application is then assigned to at least one external peer reviewer who has interdisciplinary expertise or capability in the appropriate fields of research.

Applications are assessed by the selection panel taking into account all peer reviews, along with all other applications across all disciplines in that round.

Evaluation

A final report from each funded project will identify the outcomes of the research.

Careers, training & recognition

The ARC does not fund specific training in interdisciplinary research.

Any training that does take place is within existing programmes, such as the ARC's Centres of Excellence programs, where early career researchers are funded to work with senior researchers.

International collaboration

The ARC supports international collaboration through all its programmes, with researchers selecting the best team to support the research.

"The ARC's programmes have enabled significant international collaboration in the absence of specific bilateral agreements."

Challenges in establishing the right conditions for interdisciplinary research

Identifying interdisciplinary research

"The key challenge has been to work out the best way of identifying [interdisciplinary research] and then assessing it."

"We need to be able to look at the way research is clustering around particular interdisciplinary themes, and then to work out if our programmes and policies are supporting those"

Key learnings

- Interdisciplinary research has a key role to play in achieving societal impact.
- Relevant processes, including peer review and research quality and impact assessments need to allow for consideration and recognition of the nature of, and issues involved in, research across disciplinary boundaries.
- Interdisciplinary research is evolving and there is a need for research funding agencies to better understand the nuances involved in interdisciplinary research.
- A definition of interdisciplinary research needs to be clearly articulated.

Background

The Department of Science & Technology (DST) was established in India in May 1971, with the objective of promoting new areas of Science & Technology and to organise, coordinate and promote S&T activities in the country. The DST is responsible for creating and implementing India's science and technology policies as well as taking funding decisions.

The DST also supports approximately 25 institutes of science and industry across India.

Interdisciplinary Research

While the DST has no formal interdisciplinary policy, interdisciplinary research has a key role in achieving societal impact. Research into priority areas should be problem-centric, not discipline-centric.

"The best way to encourage interdisciplinary research is to define problems which are significant, important and need to be solved, but that cannot be solved by a single discipline. If you encourage this kind of problem solving, and you encourage sufficient funding for this activity, then I suspect such teams would form spontaneously."

Priority areas are generally society-centric and cannot be solved from a single discipline.

"Problems are not defined by terms of isolated traditional domains of knowledge, they are defined by objectives and to reach those objectives you need a whole lot of different tools."

IDR is embedded in the programmes and driven by the issue itself; a call for proposals is issued and an interdisciplinary team may be required.

"If you look for example in the programme in cognitive sciences, there's a high interdisciplinary angle…some areas require input from social sciences or medical science and physical chemical sciences coming together, or engineering and technology coming together."

Assessment, evaluation & measurement

Review system

There is a core committee with a pool of other scientists.

Committees are established in areas that lend themselves better to IDR, such as material science and nanotechnology, renewable energy, water etc.

A core committee exists, with a pool of another 20 scientists that can be called on depending on the type of proposal to evaluate.

Careers, training & recognition

Capacity building

There is no formal training programme for IDR.

Researchers assemble their own team to respond to a call that requires an IDR approach.

Younger researchers are more open to working with other disciplines.

Publishing IDR

It is important to publicise the impact of IDR in order to increase recognition of the value of IDR.

An increasing number of interdisciplinary journals over the past few years has improved the situation.

The average number of authors on a publication from different departments has been increasing.

International collaboration

International interdisciplinarity is well-established for global issues.

Several centres of international cooperation exist with many examples of international IDR research, such as clean energy.

International cooperation can be virtual teams, or simply individuals working together from different disciplines.

Challenges in establishing the right conditions for interdisciplinary research

Breaking tradition

"Ten years ago we had everything neatly bundled up, organic, organic physical and so on, so it's a little bit new and people are still getting used to doing things more effectively in an ID way!"

Finding the right experts to evaluate an IDR proposal

Managing the views of experts from different disciplines

"If you have four different experts, they each evaluate a certain part of the proposal but together that's a challenging task."

Key learnings

- Interdisciplinary research plays a key role in addressing grand challenges and achieving societal impact.
- Promoting interdisciplinarity requires a shift in cultural mindsets, and it is important that sufficient funding support is provided in order to shift mindsets.
- IDR is often international in nature, in particular with regard to global challenges.
- Recognition of IDR through increased publication is important.

Background

JSPS is one of the leading funding agencies in Japan, providing funding for Japanese researchers and foreign researchers in Japan, for both basic and applied research.

JSPS was established by way of a national law for the purpose of contributing to the advancement of science in all fields of the natural and social sciences and the humanities.

Interdisciplinary Research

The main fund for Japanese researchers is called Grants-in-Aid for Scientific Research, or KAKENHI:

- It is the largest competitive funding program in Japan.
- It accounts for more than 55% of all competitive funding by government.
- It consists of a series of single-year grants
- It was reformed in 2011 by adding a multi-year fund to allow the flexible use of grants across fiscal years.
- It covers all fields from the humanities to the social sciences and natural sciences.
- It is aimed at creative, pioneering scientific research from basic to applied fields.
- It offers support for interdisciplinary research through providing a bottom-up scheme in which research is carried out based on the researcher's own creative ideas.

Assessment, evaluation & measurement

Application process

Revised in 2013 with the introduction of Integrated Disciplines covering research areas such as Complex systems and Environmental Science.

The areas cover interdisciplinary research fields which were difficult to categorise into traditional research areas, but now enable researchers conducting emerging and interdisciplinary research to apply to KAKENHI.

Review system

JSPS introduced a two-step review system under Grants-in-Aid, consisting of both the paper and panel review.

Grant-in-Aid for Scientific Research on Innovative Areas and some other research categories that promote interdisciplinary research have adopted the more advanced review system in which both processes of paper and panel review involve the same panel members (Comprehensive Review System).

This enables reviewers to familiarise themselves with the complexities of interdisciplinary research.

Evaluation

JSPS are grappling with ways to correctly evaluate interdisciplinary research.

Under KAKENHI, JSPS has some special programmes that promote interdisciplinary research:

	Grant-in-Aid for Scientific Research on Innovative Areas	Grant-in-Aid for Challenging Exploratory Research	Grant-in-Aid for Specific Research (B/C)*
Date launched	2008	2011	2014
Focus	New research areas proposed by a group of researchers in diverse disciplines, which through efforts of collective research, scholarly training, shared use of equipment, etc., will develop and lead to the enhancement of scientific research in Japan.	Early-stage research conducted by one or multiple researchers which, based on a unique idea, sets a high & challenging goal.	Based on the newest scientific trends, a Generative Research Field is established for Scientific Research (B) and (C).
Funding period	5 years	1 – 3 years	3 – 5 years (depending on the year of application)
Budget	Around US$90,000 to US$2.7 million per fiscal year & field.	Up to US$45,000 per project.	Scientific Research (B): Around US$45,000 to US$180,000 per project. Scientific Research (C): Up to US$45,000 per project.
Success rate (2015)	16%	23.6%	14.3%

Careers, training & recognition

JSPS provides support for the advancement of all fields of science and humanities including interdisciplinary research areas by carrying out a vast array of programs as well as conducting fair and rigorous peer review and thus facilitates the career development of researchers.

Capacity building in Japan is encouraged through the World Premier International Research Center Initiative (WPI), which was launched in 2007 by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in a drive to build within Japan *globally visible* research centers.

These centers are given a high degree of autonomy, allowing them to virtually revolutionize conventional modes of research operation and administration in Japan, with universities focussing on fusion/interdisciplinary research.

Challenges in establishing the right conditions for interdisciplinary research

From 2017 JSPS will set a new framework promoting large scale research projects under Grant-in-Aid for Challenging Exploratory Research.

It will promote and expand support toward interdisciplinary research.

Highly fragmented research fields (more than 300 fields for application under the fund).

From 2018 and due to the reform of the KAKENHI Screening System the introduction of broader research fields would enable JSPS to accept a wider variety of applications, and encourage interdisciplinary researchers to apply.

Difficult to find qualified reviewers for interdisciplinary research

The Comprehensive Review System will be introduced into broader research categories. Changes to the review system will bring reviewers interdisciplinary perspectives.

Key learnings

- A review of the specialization/discipline-based categorization of funding schemes is necessary to encourage applications from interdisciplinary researchers.
- Continuous training and capacity building to ensure panel members are appropriately equipped to reviewing proposals for funding and evaluating the impact of interdisciplinary research. Consistency of panel members across multiple stages of review aids in gradual familiarisation with interdisciplinarity.

*Grant-in-Aid for Specific Research funds creative/pioneering research conducted by one researcher or jointly by multiple researchers, which is classified into types A, B, and C on the basis of the total budget. Based on the newest scientific trends, a Generative Research Field is established for Scientific Research (B) and (C).

Medical Research Council (MRC)

Background

The Medical Research Council seeks to improve human health through world-class medical research, and funds research across the biomedical spectrum, from fundamental lab-based science to clinical trials, and in all major disease areas. The MRC is a non-departmental public body funded through the government's science and research budget. The MRC awards funding in both responsive mode and managed mode. In 2014/15, 336 awards were made, leading to the commitment of US$345 million for new research.

Interdisciplinary Research

The MRC does not have specific written down policies in respect of funding interdisciplinary research, but has *"ways of working"* which encourage it.

"In terms of specific hard and fast policies we don't really have any, but we have agreements across the Research Councils, we have a cross-council concordat where we work collaboratively to help each other support interdisciplinary research."

The MRC has multiple schemes under which research in general is funded. Some schemes are understood to facilitate interdisciplinary research more so than others.

Programme grants – are mostly interdisciplinary, longer term and provide much more flexible funding. They are generally around a coordinated group of related research projects that address related research questions across a broad area of study.

"The funding isn't specifically directed at particular activities. The PI and project team can allocate the budget quite flexibly and it allows for much more interdisciplinarity."

Confidence in Concept scheme – provides annual awards of US$350k–US$1.7 million to institutions, to be used flexibly to support the earliest stages of multiple translational research projects, where interdisciplinarity is essential for success.

Interfacing with other Research Councils

The MRC works with other councils to identify common priorities and grand challenges that are of common interest, to facilitate working in an interdisciplinary way.

"Experience in the past has shown that interdisciplinary research can fare less well through responsive mode. That is why we invest in cross-council programmes to mitigate this."

An example of interdisciplinary cross-council research is for an activity on Anti-microbial resistance (AMR) which was led by MRC in partnership with BBSRC, ESRC and EPSRC and focused on *"Accelerating therapeutic and diagnostics development"* in which two types of award were available:

- Collaborative grants – large scale (around US$4.25 million per project, 4–5 years duration) support for multidisciplinary teams to build capacity and capability and provide flexibility to address major questions.
- Innovation grants – smaller scale (US$280k, 1–2 years duration)

Assessment, evaluation & measurement

Cross-council review system – collaborative grants

1. Call preparation and launch – involves discussion with partner Research Councils to define scope and remit of the call, assessment process and criteria, as well as discussion of how much each partner will contribute to the funding pot.
2. Build expert panel –includes nominations from all Research Councils and discussions about the appropriate balance of expertise.
3. Outline proposals received and checked internally for eligibility.
4. Outlines assessed by expert panel and shortlisted against assessment criteria.
5. Successful outlines invited to submit full proposals.
6. Full proposals received and checked, and sent to external peer reviewers for comment – all partner Research Councils have sight of the proposals and suggest reviewers if appropriate. Once received, the peer reviews are sent to the applicants for response.
7. Full proposals assessed by expert panel and recommendations for funding agreed.
8. AMR steering committee approve the final funding decision and awards are made.

Cross-council review system – innovative grants

Similar process to the one employed for collaborative grants, except that there was no outline stage – only full proposals were received, and there was no external peer review stage, the awards went straight to the expert panel and were assessed there.

"In those situations it would be difficult to get three peer reviews that are going to cross all of the disciplines involved, so you might need to take a different approach where the assessment is more focused on the panel meeting than the review."

Evaluation

The MRC prospectively tracks research progress and captures and assesses research achievements through the uptake of Researchfish, an online database that allows researchers to provide feedback on the outputs and impacts of their research.

"Interdisciplinary research is assessed in the same way that any other project is assessed."

Careers, training & recognition

Publishing IDR

Career progression of researchers working on IDR projects might be slowed because they are not publishing in the high impact journals for their respective disciplines.

"Publishing can be a barrier because journals are very discipline based and to get good citations you need to be publishing in your discipline's top journals. If you're publishing in interdisciplinary journals or a journal that is outside your own personal discipline, you're not going to get the same recognition."

International collaboration

There are a number of international activities that MRC are involved in.

Challenges in establishing the right conditions for interdisciplinary research

Peer review

"The peer review process tends to be quite risk averse and if a reviewer feels that they can comment on their discipline, but not the rest of the project, they might be too critical of their particular area because they are looking at it in isolation."

Discipline based faculty system

"University departments are often very siloed and don't always facilitate the cross disciplinary interactions we are trying to encourage with cross disciplinary programmes, though this is changing."

Articulating the research challenge

"The biggest cross-council challenge comes in articulating the research challenge in such a way that it is meaningful to all communities. If a call uses MRC "language", it is likely to attract more medical researchers than other disciplines. It has an impact on who applies and in what context."

Key learnings

- Effective interdisciplinary research can require longer timeframes for the formation of teams and require a more flexible funding approach.
- Top-down structures are important to identify priority issues and set the challenges that require interdisciplinary solutions.
- Research funding agencies should find ways to encourage research across disciplinary boundaries, including by coordinating schemes between multiple councils across the full research spectrum.
- Relevant processes, including peer review need to allow for consideration of the nature of research across disciplinary boundaries.
- Interdisciplinary researchers, particularly those in their early career stage, should not be disadvantaged by rigid departmental and publication structures.

Background

The DFG is the largest independent research funding organisation in Germany. It promotes the advancement of science and the humanities by funding research projects, research centres and networks, and facilitating cooperation among researchers.

Interdisciplinary Research

The DFG supports projects from all areas of science and the humanities and especially promotes interdisciplinary cooperation among researchers. However, from DFG's perspective, interdisciplinary research is not an end in itself, but rather the outcome of bottom-up processes driven by scientific demand. Rather than juxtaposing disciplinary and interdisciplinary research, therefore, DFG provides for a wide range of programs within its funding portfolio that also entail specific instruments designed to support interdisciplinary cooperation.

DFG's Coordinated Programs (e.g. Priority Programs, Collaborative Research Centers, International Research Training Groups, etc.) provide a framework for interdisciplinary research, but the format/funding instrument very much depends on the way disciplines work and what they need.

Collaborative programmes account for approximately 40 percent of DFG's total funding budget of US$3.1 billion.

Assessment, evaluation & measurement

Review system

The peer review system is carefully checked and balanced by experts from all academic fields.

The structure of the DFG's Scientific Affairs Department is based on disciplines.

As experts in their respective scientific fields, DFG program directors and officers cooperate with colleagues from different fields on review questions, coordinating 48 scientific committees. Members of the scientific boards are nominated by different scientific societies and elected by the scientific communities. Scientific boards therefore consist of scientists from different disciplines.

Because special emphasis is placed on the disciplines themselves, DFG looks at questions of interdisciplinarity from a more systematic point of view.

Approval rate

There is slight, but not stable evidence that proposals for interdisciplinary projects with distant disciplines being involved face a higher risk of being rejected than those where disciplines are close.

Performance monitoring

Referees assess the outcome of any given research project, whether disciplinary or interdisciplinary, on the research objectives.

"Which challenges have been addressed in their proposal and have they been reached? Each project is treated on a unique basis."

Every three years, DFG publishes the DFG Funding Atlas, a report with key figures relating to publicly funded research in Germany. The key figures presented in this report focus on disciplines and their contribution to sharpening the profile of higher education institutions.

"Which mix of disciplines is characteristic for a particular university or higher education institution? Which disciplines collaborate in projects funded within the DFG's coordinated programmes, and which interdisciplinarities are characteristic for them?"

Careers, training & recognition

DFG-funded Graduate Schools (within the German Excellence Initiative) and Research Training Groups specifically aim for people to look beyond disciplinary borders.

This presupposes the existence of a sound disciplinary base and disciplinary skills which students should acquire during their studies.

Graduate schools should encompass people from various disciplines, but with basic expertise in interdisciplinary cooperation.

Funders should not specifically provide support for non-research skills, but facilitate interdisciplinary working by providing incentives for workshops and seminars across disciplinary borders.

The Center for Science Management in Speyer (Zentrum für Wissenschaftsmanagement) was founded by DFG to provide research administrators and managers with communication management & coordination skills.

International collaboration

Approximately 20% of participating researchers in projects funded within the DFG's Coordinated Programs scheme are from outside of Germany.

International collaboration is not a necessary condition for interdisciplinary research.

Interdisciplinary and international cooperation do not necessarily depend on funding or on the cooperation of funders.

Researchers cooperate internationally because the expertise necessary to carry out a project is based outside of their home country.

Challenges in establishing the right conditions for interdisciplinary research

Researchers need to be disciplinary experts in order to become interesting partners in interdisciplinary projects.

The quality of disciplinary, academic training, is increasingly called into question by the rising number of interdisciplinary courses of study, which might seem relevant to the job market, but are less important for the scientific enterprise as such.

Key learnings

- Relevant processes, including peer review and research quality and impact assessments need to allow for consideration of the nature of research across disciplinary boundaries.
- Interdisciplinary research builds on disciplinary expertise and skills, and thus disciplinary research needs to be visible and research training should first and foremost focus on disciplinary research skills.
- Funders should facilitate interdisciplinary working by providing incentives for workshops and seminars across disciplinary borders.

Background

The mission of the European Research Council (ERC) is to encourage the highest quality research in Europe, and in particular to support investigator-driven 'frontier' research across all fields of science, scholarship and engineering.

Interdisciplinary Research

The ERC has specific policies and practices in place for interdisciplinary research that have evolved over time and that keep evolving.

There is a history of PI-centric funding within core programmes, but with opportunities for established researchers to undertake small scale collaborations.

The ERC is aware that IDR needed specific attention within this setting.

A task force within ERC is currently looking into the policies and practices around IDR, and to establish methods of accommodating interdisciplinary proposals into the current funding schemes, including the possibility of setting up a dedicated funding scheme for IDR.

Interdisciplinary research should not be seen as an end in itself; excellent research should be funded whether it is interdisciplinary or not.

ERC reward innovative proposals by placing emphasis on the quality of the idea rather than the research area.

"The danger of the funding community is to start to treat IDR as an end in itself, it still has to pass the excellence criteria as would any mono-disciplinary projects."

Assessment, evaluation & measurement

Review system

Researchers may indicate that a proposal is appropriate for a cross-panel review, or a panel may decide that a proposal should be reviewed by more than one panel.

Review is conducted through high quality peer reviews, the establishment of international benchmarks of success, and the provision of up-to-date information on who is succeeding and why.

25 review panels exist with each covering one research field and another field in neighbouring or related disciplines.

Review panels with a broad scope are intended to mitigate risk of not encouraging IDR.

Cross-panel reviews exist where members of different panels evaluate proposals.

ERC grants are awarded through open competition, and the sole criterion for selection is scientific excellence.

Evaluation & measurement

Difficult to measure interdisciplinarity within a funding portfolio of a given agency.

Metrics and definition need further development.

In general, the achievements and impacts of IDR projects should not be evaluated differently from mono-disciplinary projects.

One key difference is that experience and achievements of researchers working on interdisciplinary projects should be formally recorded.

Challenges in establishing the right conditions for interdisciplinary research

Allocating budget

Budget is allocated at the level of three domains:

- Social Science & Humanities,
- Life Sciences,
- Physical Sciences & Engineering

In the past, a percentage of the budget has been set aside for projects that do not neatly fit into the remit of a single panel.

Setting aside budget is deemed an unsuccessful policy due to the complexities involved over which domain should fund proposals.

Encouraging IDR despite high risk, low success

The success rates of projects which span across panels have been relatively low.

Ground-breaking interdisciplinary research, where two or more fields who do not normally work together collaborate, can be deemed too risky and lengthy by researchers.

Younger researchers are generally discouraged from undertaking high risk research at an early stage in their careers.

It is important to share success stories of interdisciplinary research as encouragement.

Setting appropriate timescales

Ground-breaking research takes more than the usual research cycle of two years.

Key learnings

- Disciplinary excellence is necessary for all research, whether interdisciplinary or uni-disciplinary.
- Interdisciplinary research often carries an inherently higher level of risk and requires longer timeframes.
- Research funding agencies should encourage interdisciplinary research by developing and implementing systems, practices and mechanisms that recognise and accommodate interdisciplinarity.
- Funding agencies should actively work towards improving awareness of the success and value of interdisciplinary research amongst policy holders and researchers.
- Funding agencies should work to encourage researchers, especially those in their early career stages, to conduct interdisciplinary research.

Background

The Office of Sponsored Research (OSR) supports research at King Abdullah University of Science & Technology (KAUST) and consists of three units dedicated to this task:

- *Research Services works with KAUST researchers to develop research projects internally or with best-in-class global collaborators.*
- *Competitive Research Funds employs a global peer review process to discern the most meritorious and strategic ideas, and warrant investment of KAUST resources.*
- *Research Evaluation focuses on impact, evaluating outcomes of basic and goal-driven research, assessing how these should guide future actions.*

The university is funded from proceeds of an endowment established by King Abdullah Bin Abdulaziz Al Saud. A specific fraction of the endowment is dedicated to support research.

Interdisciplinary Research

The OSR has four funding programs which are non-disciplinary by design. Interdisciplinary research is considered as *"part of the fabric, or the genes of the university, by design".*

"We don't even try to encourage interdisciplinarity because that's what we are already."

The four funding programmes are as follows:

1. Centre Competitive Funding

Funds 11 mainly goal orientated research centres, clearly interdisciplinary, multidisciplinary, international programmes.

Centre goals can be directed towards economic development and societal benefits such as the center for Water Desalination & Reuse and the Solar Photovoltaic Engineering Research Centre.

2. Competitive Research Grant (CRG)

Grants are in the order of US$0.5 million per year for three years; the success rate is controlled by the OSR at normally around 40 percent.

3. Research Partnership Grant

A fund that facilitates collaboration between preeminent international scientists and KAUST scientists, enabling KAUST scientists access to a particular facility or expertise.

4. Ad-hoc Interdisciplinary Special Initiative/ Research (not formalised)

Identification of a specific research topic, fund at appropriate levels facilitating five end to end, cross-discipline initiatives focussing on 'sensing'.

"Given existing expertise at KAUST, we wanted to address sensing in the broad sense and we think there is science to be had in integrating the various disciplines in that end to end way."

Facilitating Interdisciplinary Collaboration

Facilitators skilled in inducing conversation and a coalescence on ideas are involved in the initial stages of team forming.

"Once the conversation has headed into some kind of coalescence, then the facilitators step out and the emergent leader in the group takes over."

Assessment, evaluation & measurement

Review system

The review system involves an ad-hoc and a panel review.

Interdisciplinary proposals are sent to people that have some of the expertise, but also reviewers with a cross-cutting background.

The panel is constructed from 10 to 20 people, depending on the proposals submitted.

"So the interdisciplinary panel can take a look at the interdisciplinary proposal without any prejudice."

"We look at who the main experts are, the most impactful people in the range of fields that we have and from there we start inviting people."

Once a panel is established, about half the panel is retained for the next competition.

"The reason for trying to keep people is just to keep benchmarking us."

Evaluation

Part of the evaluation is the quality stature of the external collaborators.

"If they collaborated with relatively weak collaborators they may not get the funding."

Performance monitoring

A science advisory board helps evaluate the success of interdisciplinary collaborations and research centres.

"They're going to evaluate how they work, the publications, the impact and all that, but one of the charges is how well are these people working together."

The science advisory board provides a report of their findings, which is presented to the centre PIs and the university leadership.

The university leadership decides on whether certain structural changes in the centres are required.

International collaboration

Every program is by design international.

Challenges in establishing the right conditions for interdisciplinary research

Ensuring interdisciplinary working evolves

The annual evaluation of research centres shows that researchers can isolate into their own disciplines.

"You want them to know that if the intent of funding is to promote interdisciplinary work, then we are going to hold them accountable to doing interdisciplinary work."

Key learnings

- Top-down structures are important in order to identify priority issues and set the grand challenges that require interdisciplinary solutions. Research funding agencies should be actively involved in the solicitation, identification and articulation of challenges as well as the provision of funding for interdisciplinary research.
- The value of research infrastructures such as research centres in facilitating interdisciplinary research should be recognised and funding considered.
- Support for training in leadership, communication, management skills and the science of team science should be offered to increase capacity and capability in interdisciplinary research; facilitation of discussions during the team formation process is to be encouraged.

Background

TAASTI is a think tank that tries to review and facilitate the emergence of new policies that deal with science, technology and innovation. Indeed, the main mission is to be the watchdog of the government as to policies related to science, technology and innovation in general, working towards the emergence of a functional, dynamic and viable national innovation system.

TAASTI's specific objectives are to:

- Contribute to the development of appropriate policies, especially horizontal ones, through a participatory approach, while ensuring adequate monitoring and evaluation.
- Promote the performance of our universities to improve the employability of their graduates and the contribution of their research output and innovation to socio-economic development, particularly in their regional context.
- Participate in the establishment of an industrial and services system based on green high value-added technologies and develop the information technology and communication infrastructure.

Challenges in establishing the right conditions for interdisciplinary research

Identification of research priorities

The Ministry of Higher Education and Scientific Research has not identified national challenges in an effort to leverage research capacities.

No research project has been intentionally launched to tackle interdisciplinary issues of relevance to Tunisia and the region.

"If we want to really have interdisciplinarity and tackle socio-economic problems it's up to the government to use the funding institution as an instrument to activate these problems, to identify these grand challenges, and of course make and put together the necessary processes and funding to actually initiate this project."

No formal interdisciplinary research policy exists and consequently there are no funds that go specifically to interdisciplinarity.

"We are wasting capacity, by not being aware of the importance of science, technology and innovation in today's transformation and transition."

Identify research capacity

The creation of research infrastructures such as laboratories and national research centres is important to identify research capacity both in terms of numbers and specialities.

Enhances the government's ability to inject money and fund research.

Research maturity

"Interdisciplinary theory requires maturity in research, experience in research and skills to do research in a group with people from different areas."

Disconnect between industry & academia

"Our industry is not up to speed regarding the value added in their products, to actually see the high level scientific and technical knowhow of academia. The industry is disconnected from the services and the contribution of academics to their business and to their production line or to their product."

Careers, training & recognition

Capacity Building

TAASTI runs condensed short courses for individuals working in public administration, providing training in public policy making.

"That to me is already a big contribution from my association to really upgrade the thinking and the mastery of these issues by the people who are actually the execution apparatus."

TAASTI has facilitated the launch of a Masters Program in Engineering and Technology Policy at ENIT.

To address the lack of expertise and programs for Science, Technology and Innovation policy research and related capacity building programs across Africa.

International collaboration

Tunisian researchers have been heavily involved in projects funded by research programs such as H2020, a substantial part of which are interdisciplinary.

International cooperation, mainly with Europe, has compensated for the absence of a relevant policy on the national level.

Researchers are connected to the international research community and seek participation in projects of relevance to their career progression.

Key learnings

- Agencies should find ways to encourage research across disciplinary boundaries, including by developing and implementing networks between science and industry.
- Provide continuous training and capacity building for government institutions around developing research policy to create the relevant environment within which interdisciplinary research can be established.
- The international nature of interdisciplinary research, particularly in relation to global challenges, is often the only opportunity for researchers in developing countries to expose themselves to interdisciplinary research.
- Top-down structures are important in order to identify priority issues and set the grand challenges that require interdisciplinary solutions. Agencies should be actively involved in lobbying the relevant agencies to articulate and prioritise challenges and channel funding accordingly.
- Disciplinary excellence is necessary for interdisciplinary research.

Background

Qatar Foundation established Qatar National Research Fund (QNRF) in 2006 as part of its ongoing commitment to establish Qatar as a knowledge-based economy. Qatar National Research Fund aims to foster original, competitively selected research in engineering and technology, physical and life sciences, medicine, humanities, social sciences and the arts.

The mission of Qatar National Research Fund (QNRF) is:

"QNRF advances knowledge and education by providing funding opportunities for original competitively selected research and development at all levels and across all disciplines with emphasis on the four pillars of the Qatar National Research Strategy:

- *Energy and Environment*
- *Computer Sciences and ICT*
- *Health and Life Sciences*
- *Social Sciences, Arts & Humanities"*

Interdisciplinary Research

Qatar National Research strategy – specifies research topics, many of which can only be addressed through IDR programmes.

Interdisciplinarity is not a pre-requisite of a research proposal – evaluation criteria is based on impact, and by their nature, some topics are better addressed through IDR.

National Purity Research Program (NPRP) established in 2007 is a bottom-up, investigator-driven program.

Encourages IDR from beginning and incentivise projects that allow collaboration.

Allows international applicants to apply in collaboration with local researchers inside Qatar.

"The National Research agenda encourages interdisciplinarity in the selection of the topic itself."

NPRP 'exceptional proposals': bottom-up approach

High impact, high risk research programmes.

Almost all are interdisciplinary in nature – allows problem to be researched into from all angles.

Budget of up to US$5million for up to five years.

Single discipline projects can develop into exceptional interdisciplinary projects when it becomes clear the project can have an impact from a different angle – these can develop into breakthrough research programmes.

Thematic and Grand changes Research Program (TGRP): top-down approach

Recent development: top-down applications where research topic is defined, e.g. Personalized medicine, where QNRF has launched a number of calls jointly funded with stakeholders such as 'Path towards Personalized Medicine'.

Assessment, evaluation & measurement

Review system

Flexible approach where PI defines team

Onus is on applicant to establish a collaboration and specify collaborators in the application.

Team is evaluated and panel will look into how this collaboration could contribute to the research topic.

Investigative-driven research (bottom-up) is more difficult to review due to being open-ended in nature, therefore this approach relies heavily on peer reviewers.

The two-tier evaluation process starts with a peer review, followed by programmatic evaluation done by a panel that includes the involvement of relevant stakeholders that will mainly assess the impact of the project and it's alignment to QNRS, comparing all the proposals submitted within a given science area.

NPRP 'exceptional proposals': bottom-up approach

2 stage submission: Initial research proposal is submitted to a sub-committee of the exceptional proposal panel where the initial proposal is presented before being given the go-ahead to submit the full proposal to the full panel.

A two-tier evaluation of peer review is followed by programmatic evaluation.

The panel review evaluates the impact of the research based on the merits that have been submitted by peer reviewers, in addition to assessing the impact of the project and its relevance to QNRS.

Thematic and Grand changes Research Program (TGRP): top-down approach

Easier to assess than the bottom-up approach; it is a two-tier evaluation process involving first peer reviewing followed by programmatic (panel) evaluation which will include the participation of the steering committee.

Challenges in establishing the right conditions for interdisciplinary research

Identifying appropriate peer reviewers

Difficult to identify peer reviewers with appropriate primary research interest and who also have a background in the relevant secondary area.

Particularly a challenge in social science, behavioural studies or applied research.

Key learnings

- Grand challenges are established through a top-down approach and the majority of grand challenges require an interdisciplinary approach.
- Interdisciplinary approaches should be at the heart of research strategy from the outset, but research proposals should continue to be evaluated based on impact not on interdisciplinarity.
- Review process should be adapted to the nature of the research to allow consideration and recognition of the different issues involved in research which crosses disciplinary boundaries.
- International nature of IDR is key, particularly for global challenges.

Appendix 1: background & methodology

Background

At the 2015 GRC Annual Meeting in Tokyo participants endorsed a 'Statement of Principles for Funding Research Breakthroughs' which, among other recommendations, stated that:

"Through their funding programs, GRC participants should … ensure support for research in diverse disciplines and foster interdisciplinary or cross-disciplinary exchanges to stimulate exploratory approaches."

The GRC recognises the need to better understand the levels of interdisciplinarity in the existing research base, and also to ensure that interdisciplinary research projects are treated fairly and consistently. Indeed, the GRC provides a unique forum for funders across the world to discuss how best to support and facilitate interdisciplinary research.

This report, published by DJS Research and commissioned by Research Councils UK (RCUK) and the Indian Science and Engineering Research Board (SERB), co-hosts of the GRC 2016 Annual Meeting in Delhi, seeks to provide the basis for further discussion on the topic of interdisciplinarity.

Objectives

The key objective of this report is to establish policies and good working practices employed by funding agencies across all five GRC regions: Africa, Americas, Asia-Pacific, Middle East/ North Africa (MENA) and Europe – that ensure interdisciplinary research is supported, facilitated and treated fairly and consistently.

In particular, viewpoints were sought from participating agencies in the following three sections:

- Establishing the right conditions for interdisciplinary working
- Assessment, evaluation and measurement of interdisciplinary research (proposal and publication)
- Careers, training & recognition

Furthermore, the functions of this report are:

- To serve as a discussion paper for the GRC Annual Meeting
- To create a useful baseline of policies and practices of GRC participants in the topic area
- To be published with the proposed 'Interdisciplinarity' Position Statement following the 2016 GRC Annual Meeting

Methodology

DJS Research used desk research and qualitative research methodologies in a two-pronged approach to assess policies and good working practices employed by funding agencies in facilitating interdisciplinary research.

Desk Research

DJS Research conducted an extensive piece of desk research to assess the plethora of literature available on interdisciplinary research. Specifically, the desk research seeks to summarize the findings of diverse pieces of research, case studies, whitepapers and government policies that address funding agencies' roles, responsibilities and limitations in the promotion of interdisciplinary research.

The analysis of published data on the subject of interdisciplinarity sets the background to the findings ascertained in the second methodology employed by DJS Research.

Depth Interviews

Depth interviews were conducted with key decision makers and influencers at GRC members across the GRC regions to provide case studies of how policies and good working practices have been implemented and adapted to ensure interdisciplinary research is facilitated accordingly.

While it was recognised that many funding agencies may not have specific policies or schemes for supporting interdisciplinarity, the good working practices embedded throughout their funding policies provided stimulus for the depth interviews.

Awareness of the DJS Research project on behalf of RCUK and SERB was raised using a brief video clip, which was shown at the regional GRC meetings held between October 2015 and January 2016. The video clip called for GRC members to participate in the project on interdisciplinary research. Moreover, potential participants were approached and encouraged to participate by RCUK representatives attending each regional meeting.

DJS Research used their dedicated in-house recruitment team for setting up interviews with GRC members who had volunteered to participate. At the recruitment stage, participants were clearly informed about the aims and objectives of the research and why their feedback was considered valuable. To help demonstrate the fact that they would be participating in a bone fide research project, participants were also emailed a letter on RCUK's letter head to confirm the commissioning of DJS Research by RCUK and SERB.

An agreed topic guide was used to steer the discussions, although flexibility was retained to probe in new and unexpected areas. The in-depth interviews were carried out by three members of the project team, all highly experienced qualitative interviewers with specific experience of interviewing senior Government officials and decision makers in Higher Education.

Interviews were carried out in English and at the respondent's convenience and lasted, on average, around an hour, although in many instances interviews were longer. All interviews (with the appropriate permissions) were audio recorded and transcribed for analysis.

The telephone depth interviews were conducted between October 2015 and April 2016.

Defining interdisciplinary research

There is an extensive theology around the differences between inter-, trans-, multi- and post-disciplinary research, each with its own shade of meaning. For the purposes of discussing policy, and indeed for the purposes of this report, DJS Research adopted the term 'interdisciplinary research' to describe research where two or more disciplines work together.

Participants in the depth-interviews were informed of this definition of interdisciplinary research prior to embarking on discussions regarding their involvement in funding and facilitation of interdisciplinary research.

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[ix] **Straub, R. and Schedlowski, M (2009) Positionspapier des German Endocrine Brain Immune Network zur interdisziplinären biomedizinischen Forschung in Deutschland [online], available:** http://www.gebin.org/fileadmin/template/media/Positionspapier0709.pdf *[accessed 22 February 2016]* (Translation from: Die übliche 3-Jahresförderung für typische Einzelprojektanträge ist kontraproduktiv, da gerade bei interdisziplinären Projekten die Anlaufphase mindestens 2 Jahre dauert.)

[x] **Ibid.** (Translation from: Gerade bei den hochgradig interdisziplinären Projekten sollte daher grundsätzlich eine Verlängerung der initialen Projektlaufzeit auf 5 Jahre installiert werden.)

[xi] **Lyall, C. et al. (2011) Identifying key success factors in the quest for interdisciplinary knowledge [online]**

[xii] **Lyall, C. et al. (2013) The role of funding agencies in creating interdisciplinary knowledge [online]. University of Edinburgh**

[xiii] **Bammer, G. (2012) Strengthening Interdisciplinary Research: What it is, what it does, how it does it and how it is supported. [online]**

[xiv] **Straub, R. and Schedlowski, M (2009) Positionspapier des German Endocrine Brain Immune Network zur interdisziplinären biomedizinischen Forschung in Deutschland [online]** (Translation from: Bei Verbundprojekten sollte der Aspekt der Core Facility zur Bereitstellung von Techniken noch mehr in den Mittelpunkt gestellt werden. Dazu sollte die geförderte Universität disziplinübergreifende Core Facilities anbieten, die als stabile Einrichtung für einen größeren Zeitraum von mindestens 10 Jahren bestehen bleiben. Im Rahmen der Förderung eines Verbundprojektes an einer solchen Universität sollten diese Core Facilties ein zentrales Element der Förderung werden, so dass die von der Universität angebotenen überdisziplinären Einrichtungen stabilisiert und auf dem neusten Stand gehalten werden können (dies gilt für die Personalstruktur als auch für die technische Ausrüstung))

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[xx] **Ibid.**

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[xxiii] **Luukkonen, T. et al. (2015) Evaluation practices in the selection of ground-breaking research proposals [online]**

[xxiv] **Lyall, C. et al. (2011) Identifying key success factors in the quest for interdisciplinary knowledge [online]**

[xxv] **Marsden, W. et al (2011) A Short Guide for Funders of Interdisciplinary Research [online] ISSTI Briefing Note (Number 8)**

[xxvi] **Lyall, C. et al. (2011) Identifying key success factors in the quest for interdisciplinary knowledge [online]**

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[xxviii] **Callard, F. and Fitzgerald, D. (2015) Rethinking Interdisciplinarity Across The Social Sciences And Neurosciences [online]. Durham University, available:** http://www.palgraveconnect.com/pc/doifinder/10.1057/9781137407962 *[accessed 22 February 2016]*

[xxix] **Ibid.**

[xxx] **Lyall et al. (2011) Key success factors in the quest for interdisciplinary knowledge [online], ESRC Innogen Centre, available:** http://www.innogen.ac.uk/downloads/Key-Success-Factors-Interdisciplinary.pdf *[accessed 22 February 2016]*

[xxxi] **Straub, R. and Schedlowski, M (2009) Positionspapier des German Endocrine Brain Immune Network zur interdisziplinären biomedizinischen Forschung in Deutschland [online]** (Translation from: Forschungsförderer sollten bei Verbundprojekten dafür sorgen, dass interdisziplinäre Lehrkonzepte integriert werden (das wird von der DFG für Sonderforschungsbereiche bereits gefordert). Daneben könnten Förderer auch gezielt langfristige interdisziplinäre Lehrkonzepte an den Universitäten etablieren, die über die Förderzeit eines üblichen Verbundprojektes hinausreichen.)

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