“Overcoming Barriers to Cross-disciplinary Research” X-Net workshop outcomes

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Workshop Purpose

Cross-disciplinary research is rapidly becoming the norm for many researchers and research teams who seek to break the barriers of their disciplinary silos to find solutions to some of biomedicine’s trickiest problems. However, crossing disciplines in often mono-disciplinary institutional structures and cultures creates problems and barriers for individuals and teams that need to be overcome. The X-Net project aims to highlight these barriers and prioritise those that require dismantling first. Its first step is to identify personal and cultural challenges that individual researchers embarking on this cross-disciplinary journey may be facing.

Therefore, this workshop aimed to provide an opportunity for participants to:

- define personal barriers for cross-disciplinary research;
- define institutional and cultural barriers for cross-disciplinary research;
- share experiences through discussion with peers;
- start to consider specific actions to overcome personal and cultural barriers through action learning and reflection.

Workshop Attendants

The workshop was designed to engage interdisciplinary researchers in an interactive discussion about the main obstacles of the interdisciplinary research landscape in the UK. There were 30 participants from different institutions and career stages (from PhDs to well established independent researchers) in attendance:

- **University of Edinburgh**: 20 participants
- **University of Dundee**: 4 participants
- **University of Oxford**: 4 participants
- **Industry**: 1 participant
- **Others (UK academia & research institutes)**: 1 participant

All the participants were asked to complete a pre-workshop anonymous survey that would allow them to identify and share some of their personal concerns/barriers for being a cross-disciplinarian. The responses were used during the workshop to find common themes or challenges that participants have experienced and informed the workshop focus.

Workshop Structure

The workshop was delivered online for a duration of 3 hours. As an initial ice-breaker activity, participants were asked to choose one photo in Padlet that best represented how they felt about inter and cross-disciplinary research, and were then given time to introduce themselves in small break out groups and explain why they chose that picture.

After the initial introductions, in the first half of the workshop the focus was on defining common barriers to cross-disciplinary research. Small breakout group discussions were used to allow groups to define and list some common barriers to cross-disciplinary research, and to vote on those most important to them. Opinions were collated using Padlet.

In the second half of the workshop the focus was more on finding solutions to these barriers. First, two of their peers discussed specific challenges they had encountered when crossing disciplines. Small breakout groups then provided solutions for their peers' challenges. The peers then presented what was actually done to overcome these challenges. Second, participants were introduced to the concept of action learning sets to work through personal challenges in their own settings. Participants were then given time in small breakout groups of 3-4 to reflect on specific actions they could take to overcome personal barriers. Padlet was used to collate their reflections on one thing they could do, and one change that is needed to better enable cross-disciplinary research. Finally, the workshop ended with links to further resources to help them find appropriate further support.

Feelings on interdisciplinarity

Participants were asked to choose one photo that most represented how they felt about inter or cross disciplinary. Results can be seen in the image below. Some of the comments following this exercise shows how participants felt, and why they chose those pictures.

"I think it would be interesting to see how those pictures and likes are distributed with regard to the stage of the career. Like the most optimistic ones versus the pessimistic."

"I chose the ants just because I think they're this community of scientists like working together potentially being one of the most vulnerable to go down."

"In an ideal world, basically, I would have actually chosen the group of ants, you know, trying to do something productive at the end of the day. And this should be the definition of cross-disciplinary or multidisciplinary. But I personally chose the lady on top screaming, because I feel that, they know the difficulties of working in different groups and in different disciplines. It's difficult. And because of that, you sometime end up in a situation that for every step that you are going to take, you have to basically deal with quite a lot of basic issues. And you have to learn quite a lot, and have energy and the resources."

"So I was halfway between the lady with red hair and the Picasso-esk painting, which I suppose shows the sort of 2 different sides of what I've seen. It is that you get the Picasso-esk painting when everyone's working together, and it's all working, you get lots of these different sides coming together to the same and it works really well, better than anything by itself. But then, also, when it doesn't work, especially when people are not listening to one another, you can get quite frustrated"

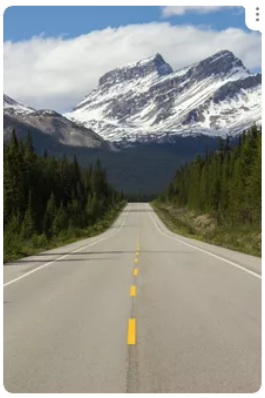
padlet

ewoollen · 3h

How do you feel about inter and cross-disciplinary research?

Choose one photo that most represents how you feel about inter and cross-disciplinary research by clicking on the heart icon at the bottom of the photo. All contributions are anonymous.


♡ 1


♡ 2


♡ 3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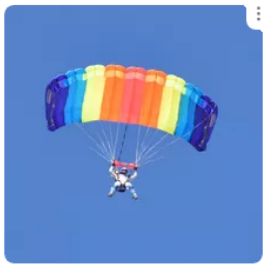
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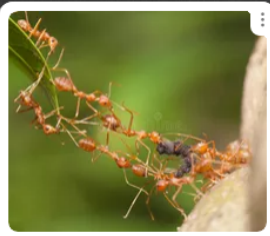
♡ 6

Defining common barriers

Participants were given four main themes for barriers, which were based on the prevalent barriers reported in the pre-workshop survey data. These were: 1) Cultural barriers, 2) Personal barriers, 3) Institutional barriers, and 4) Procedural barriers. Groups then listed common barriers within each theme, before being asked to vote for the top 3 within each theme that were most important to them (see Appendix 1 Table 1 for the full list). The following summarises key barriers within each theme.

Cultural barriers

Within the cultural barriers, the most voted for barriers included:

1. Understanding limitations of each other's methods (3 votes)
2. Publications: Number (and order) of authors, REF, Citations, etc. (3 votes)
3. Finding a common language (2 votes)
4. Mistrust/antagonism between computational and experimental scientists (2 votes)
5. Lack of close collaboration and miscommunications that arise from that (2 votes)

These barriers suggest that most participants had encountered cultural barriers related to:

- difficulties of communication across disciplines causing lack of understanding
- differences in publication and authorship practices with impacts on evaluation
- difficulties in establishing positive team dynamics, causing lack of trust and understanding between collaborators

Other barriers included perceptions of being unequal contributors or receiving unequal benefits, as well as differences in disciplinary timescales, goals, and levels of criticism (see Appendix 1).

Personal barriers

Within the personal barriers, the most voted for barriers included:

1. Difficulty to communicate with researchers with different backgrounds (4 votes)
2. Hard to know what is an interesting question in another field (3 votes)
3. Finding time to learn (3 votes)
4. Jack of all trades, master of none (3 votes)
5. Lacking broad knowledge base in your field (2 votes)

These barriers suggest that most participants had encountered personal barriers related to:

- Difficulties of communication across disciplines
- Difficulties in establishing shared research questions and goals
- Difficulties in finding extra time needed to learn a new discipline
- Issues with confidence and research identities

Other barriers were related to going beyond one’s comfort zone and being able to discern what you are good or bad at, which relate to lack of confidence, and the need for more time to learn new disciplines/methods.

Institutional barriers

Within the institutional barriers, the most voted for barriers included:

1. Universities structured by discipline-specific departments (5 votes),
2. Funding/fellowships often discipline-specific (3 votes),
3. Training for Supervisors (3 votes),
4. Training programmes (3 votes),
5. Issues of elitism (2 votes),
6. Journals are often discipline-specific (2 votes).

These barriers suggest that most participants had encountered institutional barriers related to:

- Difficulties navigating disciplinary structures of universities with implications for progression and evaluation.
- Difficulties finding/applying for funding and being evaluated fairly by funding panels.
- Lack of training for supervisors and group leads on how to support cross-disciplinarity, and also lack of training for researchers to get up to speed in another discipline.
- A perception of not being valued equally or being treated differently.
- Difficulties getting published in discipline-specific journals, and implications for evaluation.

Other barriers included physical arrangements or lack of spaces limiting collaborations and team work, and feelings of isolation in disciplinary structures.

Procedural barriers

Within the procedural barriers, the most voted for barriers included:

1. Lack of a procedure (often) to define the area of expertise of the people who review or comment on a given work/manuscript/grant application (3 votes)
2. Difficult to lead and encourage students to find what they're good at (2 votes)
3. Training in undertaking lab work [or mathematics/programming/statistics] (2 votes)
4. Local leadership and management support for interdisciplinary research important (2 votes)

These barriers suggest that most participants had encountered procedural barriers relating to:

- Difficulties getting fair evaluation related to funding, publications and career progression
- Issues with supervising/leading others effectively
- Lack of training on key skills in another discipline
- The need for strong leadership and management locally

Other barriers included lack of guidance on how to meet expectations and the need to fit into disciplinary structures for PhD students, issues around equity and funding, as well as lack of or difficulty finding networking opportunities.

Other barriers

There was also an opportunity for participants to include other barriers that didn't fit within the themes. The most voted for 'other' barriers included:

- Diverse publications...for early career researchers this may hinder future career prospects (3 votes)

- Negative Perceptions: Jack of All Trades. Masters of None (3 votes)
- Conferences and where to present to get network and recognition (3 votes)

These barriers suggest that most participants had encountered barriers relating to:

- Difficulties with evaluation with diverse publication records and implication for career progression
- Negative perceptions of others and/or yourself hindering effective cross-disciplinary research
- Difficulties finding or lack of opportunities to network, with implications on career progression.

Other barriers mentioned included difficulties with publications including having to simplify concepts or add in further explanations, or publications that are unnecessarily interdisciplinary or overly complex.

Discussions on barriers

Following this exercise, some of the discussions around the barriers included that there was a common element of issues around evaluation across the themes, as well as communication issues and negative perceptions and how others view us hindering cross-disciplinary research. There were also discussions around barriers related to 'where do I fit?' and implications of structures on our identities, who we work with, how we work, and what opportunities there are either networking or funding related. Further discussions also included comments on how all of these barriers were interconnected to each other, and that is was difficult to separate them out into themes. Indirect barriers were also mentioned, such as how we are valued in other's eyes if their norms and cultures are different to our discipline.

There was also a discussion around what might influence someone perception of what was a barrier or not. One person mentioned that it was probably related to what kind of interdisciplinary researcher you were, whether it was an individual crossing disciplines or teams working together, as well as impacts of career stage on what was perceived as a barrier. Someone else also mentioned that what environment you worked in was important, whether it was individuals working in isolated departments or a supportive collaborative environment.

Finding solutions – case studies

The two challenges presented by two peers were:

1) Challenge of communicating across disciplines to find appropriate research questions
2) Challenge of recruiting suitable researchers to interdisciplinary positions

The solutions offered by groups for these two challenges included

For challenge 1:

- Organise an away day for the collaboration
- Better communication & explanation. More open minded and humble approach & put aside preconceptions.
- Having a designated messenger/translator: the cross-disciplinary person

- Visual representations; get everyone in the same room; show control result before new results
- Research culture where not afraid to ask silly/many questions
- Learn how to present your research in layman terms/ meet often with collaborators

For challenge 2:

- Advertise outside your university. Include experts from different fields in the interview panel.
- Link with Teaching Programme Coordinators who decide the content of the UG & MSc taught programmes & content should reflect XD requirements down the line. Issues of academic snobbery but student's needs to get to try lots of different things. Also need to raise awareness of newish field of Bioinformatics – how it's advancing & the increasing breadth across the field. The way we think about education needs to change - what works for universities may not work for students or industry etc. TRAIN THEM to extend their expertise. Identify key attributes you need – you can train on everything else. Email Bioinformatics Masters Programme to advertise posts.
- More opportunities for interdisciplinary training at early career stages.
- To recruit PhDs. Find flexible programs. Apply for funding for a specific project.
- Develop network/connections at conferences and other schools; use appropriate keywords (from other fields) in job descriptions
- LinkedIn-like network; be open-minded regarding individual's specific background—they may have the potential to learn even if they don't already have the knowledge already.

The actual solutions to these challenges as presented by the two peers were:

For challenge 1:

- Regular meetings with the core team several time a month, especially during the first year of working on the project we will meet once a week, and sometimes we will meet once every 2 weeks for more advanced stages. Sometimes we will meet more than once a week as is required. In these meetings it was very important to make sure that everybody was as much as possible on the same page. This meant extensive explanations and repetition, finding different ways to say the same thing.
- In order to find a precise question, it just requires a lot of conversations, and actually a lot of failed conversations. From all of the failed conversation, there will come questions that were worth pursuing.
- Have a team that has genuine scientific interest from everybody involved. Even if they are extremely successful at what they do, and they already have a career in their fields, they need to be curious to want to explore a different direction of research. Curiosity is the key. Find people whose eyes shine for what you are doing.
- You need patience. It's a lot of work to understand one another, it requires to say things in different ways, to be very open up to not understanding, and to find a manner of communicating that is effective. This is going to take patience, and in some circumstances, it can even be boring for those in our disciplines, or for ourselves, to have to explain things again.
- It requires courage and commitment. This type of work can be a little bit scary. It's something that we have no previous experience of. So, in order for us to be successful, we

have to work really hard and focus on what we are doing. But at the same time, you also have to let go, and try something new. You need to trust those who are advising you. It's like a juxtaposition of trying very hard, but at the same time trusting that things will turn out fine.

For challenge 2:

- Try and get some work done through co-Supervision of MSc students in other departments. This creates links with other departments, and it's a good way to get some students with the required skills. The plus side is you get to work with new collaborators and they might provide some new input into your work. On the downside is you end up having to share credit for your ideas as second supervisor, even though you provided the project idea, and you may also not be able to control what research you want done.
- Get involved with a bit of undergraduate teaching in other departments. Give guest lectures in courses that you research in, for example. You can start to sow the seeds with the undergraduate students in that department, who might get to know you and consider you when you have a PHD position, and similarly with top training centres in our department.
- Consider a co- affiliation with another department. It might help with recruitment if you are affiliated with another department. The downside is it can take a lot of time. So, if you find a head of department in your guest department that is happy to give you affiliation, maybe in return for some teaching, it can take a lot of time. It took 3 years from the head of department agreeing to for my name to actually appear in the list of co-affiliated people.

Finding solutions - personal barriers and reflections

The final exercise was around solving personal barriers to cross-disciplinary research. The facilitator had intended to use short action learning sets, but due to time limitations, the facilitator explained how participants could set up their own action learning sets in their own settings, and how these could be powerful ways to work through personal barriers to inter and cross disciplinary research through group coaching.

Participants were instead given a chance to reflect on what they had learned from the workshop, and to share those reflections by writing into a Padlet one thing they had learned or one action they would take as a result of the workshop, and one change that would better enable cross-disciplinary research. The results are shown below in the speech bubbles.

One action you will take or something you learned

I learnt that some things are easier for the XD researcher, and many are harder

Keep courage, curiosity, and be open-minded for XD research

It's just as difficult to train and recruit cross disciplinary people as it is to be a cross disciplinary trainee

Action: Create connections with other schools/ departments to be able to recruit students with different sets of skills

Starting open dialogue with collaborators to attempt to break down preconceptions about skills/ motivations/ interests and make people feel at ease with working together (rather than being defensive)

Networking and using experience of some senior members who already have gone through the path. Need some departmental and institutional changes in addition to personal efforts.

Institutions need to be mindful of who they recruit in leadership positions. Appointing people who are willing to enable XD research and work to enable connect people and ideas.

Many problems are common across XD researchers regardless of background

The importance of effective communication to inform... address misconceptions & preconceptions... build trust & mutual understanding... encourage everyone to be open to each other & start to work as a supportive curious team

Funding structures and solutions are different in other countries. I learned in a breakout discussion that China, for example, has opened up funding specifically for interdisciplinary research ("top-down" push for interdisciplinarity).

The benefits of becoming affiliated with multiple institutions

One change that will enable crossing disciplines

A cultural shift to place more value on interdisciplinary research by funding bodies, training programmes and individual researchers.

Change: Grant review panels. They need to be better matched to XD research or more flexible, otherwise we end up forcing a grant into UKRI sub-disciplines

Researchers being more willing to talk about their work in an easy to follow way, to a wide audience

Having funding (for individual PIs as well as large teams) that allows interdisciplinary work, rather than being tied to specific disciplinary remit.

Change: Getting better recognition for shared contributions in cross-disciplinary papers (several first/last authors)

Seems accepted that XD research takes longer, so XD fellowships/contracts should be longer if expect comparable output

To encourage individuals to apply for cross-disciplinary posts: (1) review the "essential" vs. "desirable" criteria - some people will have the ability to learn quickly; (2) include a section on the job description regarding training and support that will be made available for the post-holder.

Building more time into fellowships/PhDs for training cross disciplinary work.

Biomedicine becoming more open to papers with multiple joint first/last authors with equal contribution.

Both sides (single disciplinary and XD) need to be more tolerant

more XD workshop, both training workshop in a 'soft' way like this one, and also technical training workshop

Career advice for graduates/PhDs that shows the breadth of fields where they could apply their skills

Giving early-career XD researchers the correct support so it's less of a lonely transition

Dedicated time and opportunities for training in your new discipline

Appendix 1: Common barriers Padlet output

Table 1: All common barriers as listed in Padlet within themes with the subject, body, number of votes and further comments by participants.

Theme	Subject	Body	Votes	Comments
Cultural barriers (e.g. difference between disciplines)	Understanding limitations of each other's methods	mathematical models aren't magic... and experiments can't do unlimited replicates	3	
	Publications	- Number (and order) of authors - REF? - Citations - etc.	3	as a theoretical/computational biologist, do you get stuck as a middle author in a collaboration with experimentalists? Yes - Even for papers that I have written almost entirely myself
	Finding a common language		2	
	Mistrust/antagonism between computational and experimental scientists.		2	
	Lack of close collaboration and miscommunications that arise from that		2	
	Publication Issues	Timeline differences between fields Variation in IMPACT i.e. How your outputs are measured	1	
	Building a team	Allocating sufficient time to get to know each other, understand each others' strengths & weaknesses, finding ways to work effectively together. be clear on the common goals want to achieve together	1	
	Treating computational collaborators as a "service"		1	
	Comfort in admitting lack of understanding - can lead to miscommunication		1	
	Avalanche of acronyms		0	
	Area-specific "languages"		0	
	Statistics vs Data Science vs ML vs AI		0	
	Impact factor differences between disciplines/ journals		0	
	Rewarding specialism vs generalist		0	
	Disproportionate allocation of resources/personnel		0	

	Publication frequency and size	frequent small papers vs. big papers that take longer, or conference abstracts vs papers	0	
	International travel	hard to breach actual cultural barriers	0	
	Can we learn from Industry	archaic, hierarchical system in academia v. more equitable team work recognition in industry	0	fail as a team or succeed as a team
	Timeline differences - biology takes a lot longer in the lab than some computational methods		0	
	Different levels of acceptable criticism in seminars / literature		0	
	Difference in goals: "product" vs "science"		0	
	Different cultures related to meritocracy vs job title hierarchies		0	
Personal barriers (e.g. skills, abilities, interests)	Difficulty to communicate with researchers with different backgrounds		4	
	Hard to know what is an interesting question in another field		3	
	Finding time to learn		3	
	Jack of all trades, master of none		3	
	Lacking broad knowledge base in your field	teaching, going to seminars etc. in a department where you didn't study	2	
	Going beyond the comfort zone of a known field		1	
	Learning 2 fields at once means that things take a bit longer		0	
	Differentiating between the things that you're good and bad at, being a student in one field and a master in another		0	
Institutional barriers (e.g. structures, funding, publication, progression)	Universities structured by discipline-specific departments	where do you fit as an interdisciplinary scientist looking for a job?	5	also, getting credit for work (teaching, mentorship, involvement in seminars, etc.) done across different departments. // E.g. to recruit students from another departments program if you are an interdisciplinary team
	Funding/fellowships often discipline-specific	e.g. UKRI divided by discipline-specific councils	3	
	Training for Supervisors	To help supervisors to enable their students & team members to be their best - have time to get to know	3	how to manage/train a team with diverse experiences/interests once you are a group leader

		them, what motivates them, where they need support, where they can be left to get on with things with minimal supervision		
	Training programmes	To recognise that people need to get up to speed in a new fields fast, requires a programme of seminars etc - introductions to X topics	2	
	Issues of elitism	Issues of some biologists not recognising / valuing computational researchers and making them feel small for not understanding specialised biology	2	hubris of physicists// goes both ways
	Journals are often discipline-specific	hard to find a home for interdisciplinary work	2	
	Difficulty getting appropriate reviewers for cross-disciplinary grants		1	
	University appointments often tied to teaching component	And a cross-disciplinary researcher may not be able to teach the topic of the department he researches	0	
	Not fitting into a normal hierarchy		0	
	PhD Training Centres don't recruit for x-disciplinary research		0	
	Physical arrangements to facilitate collaborations	Ensure that XD teams are located together and can work in the same space - help people to think & work differently	0	
	Territorial issues re using equipment	Mine versus theirs! Specialist equipment should be accessible tall through a fair booking system	0	
	Isolating/frustrating for XD students to be without XD peers		0	
	Degree courses don't allow much XD work		0	
Procedural barriers (e.g. leadership, management, resources, support)	Lack of a procedure (often) to define the area of expertise of the people who review or comment on a given work/manuscript/grant application.		3	
	Difficult to lead and encourage students to find what they're good at		2	similarly - knowing how to communicate with and guide students/postdocs/mentees

				with different disciplinary backgrounds
	Training in undertaking lab work		2	also training to do mathematics or learn programming and statistics
	Local leadership and management support for interdisciplinary research important		2	
	Reliance on funding in experimental science		1	
	Requirement for phd students/fellows to have a sufficient amount of the school's discipline in the thesis - can lead to lower quality science		1	
	Lack of guidance for MSc/PhD milestones for XD projects	e.g. in biology department, guidelines for progression and reports focus on fieldwork & lab work, not theory/computational projects	1	
	Adequate space for people or for kit		1	some (perceived to be less important) disciplines get overlooked in terms of ordering kits within disciplinary grant applications
	Networking opportunities		0	
Other (add any others that don't fit these themes here)	Diverse publications...for early career researchers this may hinder future career prospects?		3	
	Perceptions: Jack of All Trades. Masters of None		3	others perceptions of you, but also your perceptions of yourself (imposter syndrome)
	Conferences and where to present to get network and recognition		3	
	Adding explanation boxes/snippets in papers for scientist readers simplifying deep concepts used in the work, in case it is out of the realm of the major discipline (eLife does that sometimes).		0	
	Frankenstein papers		0	that don't need to be interdisciplinary // this may also arise due to lack of communication between disciplines and insufficient knowledge exchange - you may end up solving a problem in one discipline in a very convoluted way that could be solved in a much simpler way, only you were not aware of it.