

Table S1. Topic guide for researchers/academic staff.

| Research education | Research practice | Relationship with industry |
|--|--|--|
| Which topics in research methodology you consider as most important? (Research integrity, open science, academic integrity, GDPR, transparency...) | What does interdisciplinary research mean to you? | What challenges do you encounter when doing (or trying to do) research with industry? |
| What challenges do you encounter when involving students in research? | What benefits do you perceive from interdisciplinary research? | What kind of institutional support do you think is needed for connecting students with industry? |
| What support do you need? | What challenges do you encounter when involving students in interdisciplinary research? Would you give an example? | |
| | What kind of institutional support and policy do you need for this kind of research? | |

Table S2. Topic guide for students.

| Research education | Research practice | Relationship with industry |
|--|--|--|
| How prepared do you feel for research with your education? | What does interdisciplinary research mean to you? Do you have any experience with it? | What are your experiences in working with industry? Do you have experience at all? |

| | | |
|--|---|--|
| Do you feel that there are some topics that are missing from the curriculum, or do you think that everything is covered? | What are the problems and challenges that you face when you do interdisciplinary research? | Does your study program push you and help you to work with industry? |
| What was good in your education programmes, about research, what really worked and what do you think is important? | Is there anything that could be changed in the way your study program is designed, or is there anything to change in the classes you take that would help you to make those challenges smaller? | Does your study program push you and help you to work with industry? |

Table S3. Themes developed from qualitative analysis and participant statements.

| THEME AND CHARACTERISTIC | PARTICIPANT STATEMENTS |
|--|--|
| Theme 1: Existing barriers and facilitators to IDR and IAC | |
| <i>Subtheme 1: Differing viewpoints and beliefs about interdisciplinarity and IAC</i> | |
| Differences between researchers/staff in understanding interdisciplinarity. | <i>UG, Researchers/Staff: "I'm not sure what my conclusion would be even after two hours of discussion about interdisciplinarity. I'm not sure to really understand what the difference is between inter- and multidisciplinary."</i> |
| Interdisciplinarity is a common occurrence in science. | <i>UNIST, Researchers/Staff: "So in my field of research, we also need knowledge of many other (...) fields of science, like (...) psychology and sociology (...) There are many other technologies that are needed to obtain my works."</i> |
| Interdisciplinary research has more potential in creating new methods and knowledge for solving research problems. | <i>UCA, Researchers/Staff: "(...) I would also agree that interdisciplinarity not only takes knowledge of different disciplines to find a new solution to a problem, but also it allows us to see different problems within the same matter (...)"</i> <i>UNIST, Students: "(...) I would say that interdisciplinary research is a great opportunity to share concepts and methods developed in one discipline across an area of different problems."</i> |
| Interdisciplinary research relevant for students currently/in the future. | <i>UCA, Students: "[Ecology] is maybe the most important field related to urban planning (...) I would say that we need to have a sensibility of that in the environment and the ecological issues (...) but you need to have knowledge in the related laws as well."</i> |
| Interdisciplinarity is becoming a buzzword for grant applications. | <i>UNIST, Researchers/Staff: "I think if we have problems, which always we have, then they stem from this (...) superficial approach to [interdisciplinary] collaboration. People usually start talking about collaboration, not about hypotheses."</i> |
| Divergence with industry-academia collaborations. | <i>UNIST, Researchers/Staff: "When you have a corporation, you have research and development... So, speaking about science and the industry is, I agree, completely wrong."</i> <i>UCA, Students: "I think that collaborating or working with companies (...) is quite difficult because what I'm doing is what we actually call basic science. I don't think (...) I would benefit from collaborating with companies."</i> |

| | |
|--|--|
| <p>Industry stakeholders expect short-term results, which researchers cannot easily deliver</p> | <p><i>UCA, Researchers/Staff: "[It] is very difficult to work with big companies and give them the results (...) and the data on time (...)"</i></p> <p><i>UG, Researchers/Staff: "[A industry-academia collaboration] must work as an open-source project where you have all the access for free and you can modify this project. And this is where I'm the most afraid of working in industry, that this patenting goes too far beyond the point where it makes sense... I don't know if an idea is applicable to being commercial or should it be available for free for the whole humanity who paid for it already by paying my salary."</i></p> |
| <p>Researchers from the industry have a better perception of research problems and can offer new methods.</p> | <p><i>UCA, Researchers/Staff: "From an academic point of view, it [industry-academia collaboration] may be interesting because sometimes you're working on original issues or problem statements. So, it makes your research original."</i></p> <p><i>UCA, Researchers/Staff: "Sometimes you have to experiment with them, and probably some other disciplines, some work depends on working with industries (...). So, you always learn about application domains. It's a way to validate your results."</i></p> |
| <p><i>Subtheme 2: Traditional HEI structures and bureaucracy prevent IDR and IAC</i></p> | |
| <p>Traditional HEI structures one of the main barriers do IDR.</p> | <p><i>UCA, Researchers/Staff: "But within universities, I feel that there is some lack of communication among different departments, and also outside the universities."</i></p> <p><i>UM, Researchers/Staff: "At the University of Malta, you have four institutions, four sets of bylaws, four sets of deans and directors (...) there is an institutional dimension here. You are just brought up in one department and you just don't bother to look elsewhere because it's difficult."</i></p> |
| <p>Seminars/conferences as tools for overcoming barriers.</p> | <p><i>UM, Researchers/Staff: "I guess conferences (...) because you can discuss with other people, get different takes on something, something might not have thought of before."</i></p> |
| <p>Lack of trust towards higher education institutions as "Ivory towers"</p> | <p><i>UG, Researchers/Staff: "So this is a huge challenge... to have a mark that the university is a kind of brand which also provides you with legal assistance."</i></p> |
| <p>Higher education institutions do not validate interdisciplinary research or industry-academia collaborations.</p> | <p><i>UCA, Researchers/Staff: "(...) the evaluation process is penalising the publications with many authors."</i></p> <p><i>UG, Researchers/Staff: "So even though I'm collaborating with people there (...) it's very difficult to know how or if that can be turned into some sort of formal thing that is recognised here, rather than just being an informal kind of collaboration."</i></p> |

| | |
|---|---|
| Subtheme 3: Differences in publication standards and research backgrounds | |
| Differing publication standards between disciplines a critical inhibitor to ID collaborations. | <i>UNIST, Researchers/Staff: "...you have a publication in one field, and you did something. For example, I speak about computer science. You did a very simple method, for example, image processing in the MRI. Did you make a breakthrough in image processing or in the medical field?"</i> |
| Difference in "starting" knowledge of researchers and student. | <i>UBO, Researchers/Staff: "We don't always have the same objectives. Also, we both have several projects running at the same time. And so, the priority we give to the common project is not always the same." UCA, Researchers/Staff: "[There is a] big sort of start-up cost to engaging into interdisciplinary research, because (...) the sort of language used between the different disciplines is often totally different, even when talking about the same concept."</i> |
| "Open science" and the fostering of "open communication" as the solution to the knowledge-gap problem | <i>UBO, Students: "I think that open science and transparency are super important... you need to share your data, you need to share your codes to allow other people to reproduce your work and progress on it."</i> |
| A researcher's/student's "specialization" or training in a specific poses problems in collaboration. | <i>UM, Researchers/Staff: "When you come to collaborate with someone who's coming from a different area (...) you might find a bottleneck [preventing collaboration] in the sense that you are actually familiar with different literature." UNIST, Researchers/Staff: "...this kind of education, which is happening today (...) inside the traditional disciplines, it's something (...) giving a lot of problems for us who are leading any kind of [interdisciplinary] research or trying to do any kind of [interdisciplinary] education with the people who are coming from (...) traditionally educated background."</i> |
| Subtheme 4: Non-academic factors inhibit IDR and IAC | |
| Interpersonal factors inhibiting interdisciplinary collaborations. | <i>UBO, Researchers/Staff: "I want to mention as well that (...) in interdisciplinary topics (...) the human factor is a little bit more relevant, to some extent." UBO, Researchers/Staff: "What is very important with interdisciplinarity is to be humble with what your discipline can do. You have to be very aware not to take your discipline too seriously."</i> |

| | |
|---|---|
| | <p>UCA, Students: "I think that (...) some kind of competitive attitude between the specialists who are not always open-minded and transparent while working (...) is an obstacle for research."</p> <p>UCA, Students: "Something I think is very important (...) respected science, if that makes sense (...) because I have the feeling that egos in science are quite high and sometimes (...) they [researchers] don't respect each other opinions."</p> |
| Language and culture can also affect research. | UBO, Students: "The major drawback for me was (...) the language, because sometimes it's not easy to talk about science because (...) the scientific vocabulary [is] more difficult than expected [when you] try to learn how to speak the language." |
| Theme 2: Increasing the involvement of students in interdisciplinary research and industry-academia collaborations | |
| <i>Subtheme 1: Different academic backgrounds and traditional higher education institution structures prevent student involvement</i> | |
| IDR difficult for students due to academic background and single-discipline education. | UBO, Students: "If the students do not feel good enough to express the lack of knowledge or any potential issues that he/she will have, they will just interact with other students and not with you, and then you will lose also some efficiency in the project." |
| No support for students doing interdisciplinary research. | <p>UCA, Researchers/Staff: "My experience is that interdisciplinarity is quite difficult. I don't know if that is a problem specifically of the law degree, but it seems that there is clear compartmentalization of disciplines."</p> <p>UNIST, Researchers/Staff: "So for me, one dominant problem in our country is (...) of formal nature, for example, it is difficult to acquire formal education in interdisciplinary research... someone wants to obtain a doctorate in the interdisciplinary field of science, then you first you have a problem that your research or its scientific outcomes (...) [and its] scientific contribution is not enough (...) in the individual, traditional disciplines to which most graduate student programs, doctor programs are adapted."</p> |
| No method of contacting people from other disciplines or in industry. | UG, Students: "(...) more opportunities for networking, even here in the university, would be really good because, for example, as you said, maybe I could collaborate with mathematicians here..." |

| | |
|--|---|
| | <p>UNIST, Students: “Maybe it will be a good idea for future development of this interdisciplinary approach to do some joint classes on the communication skills.”</p> <p>UBO, Students: “If there was something that could help develop your personal network with stakeholders, that would be interesting. That’s what I see now directly, because sometimes it can be hard to know to which person you need to talk about some subject.”</p> |
| Time constraints for students and researchers. | <p>UBO, Researchers/Staff: “The time (...) to teach the student before he is able to conduct the experiments by himself (...) can sometimes be very tricky, especially if you have to supervise the students for a short internship.”</p> <p>UNIST, Students: “(...) In my case, the interdisciplinary research involves biomedical researchers and physicians while I am a master student. But, although my project involves working with specialists from other disciplines, they usually had very little time to discuss the project with me.”</p> |
| Subtheme 2: Research methodology courses, practical work, and research mentorship increase the involvement of students in IDR and IAC | |
| Lack of pre-university and university-level education on critical thinking and research methodology. | <p>UBO, Researchers/Staff: “(...) the most important thing in making this kind of methodology is acquiring new knowledge, sharing knowledge (...).”</p> |
| Lack of practical work impedes student research participation and demotivates them from pursuing research careers. | <p>UG, Students: “I think I’m prepared, but I would have liked my degree to have more activities.”</p> <p>UCA, Researchers/Staff: “That’s the most challenging, to take them outside of our crazy world where papers, the impact factors and all these stupid things, which are indicators, not science at all, are important.”</p> |
| Research methodology education needs to contain practice. | <p>UBO, Students: “I realized during my internship, it was hard and stressful because, in fact, a lot of my tasks didn’t go out like the way I planned (...) if it doesn’t work, I just have to find another way to make it work.”</p> <p>UG, Students: “Maybe I can agree with SPEAKER 11 that [there should] be more open-door days (...). Like to show them to show us. It may be more about the research topics and stuff like that (...).”</p> |
| Mentors are crucial in advancing students’ research interest. | <p>UBO, Researchers/Staff: “There is another level of communication that you have to deal with when you get students involved – the communication between students and their supervisors (...) You have to build also trust between the student and the supervisor to some extent.”</p> |

| | |
|--|--|
| <p><i>Subtheme 3: Projects, internships, and international exchanges increase students' career opportunities</i></p> | |
| <p>Universities should actively engage students in research and organise networks for students to use and find internship or research opportunities.</p> | <p><i>UNIST, Students: "We miss to be included in some research to try something by ourselves, so that's, I think, the problem... there is no education where we could just go and say, OK, I would like to be a part of some research."</i></p> |
| <p>International internships and exchanges improve student skills.</p> | <p><i>UCA, Students: "(...) probably more funding for practical techniques and practical training and also, as my colleague said, in an exchange between universities in Spain and abroad to allow for further training and courses or seminars."</i></p> |
| <p>Higher education institutions should create research jobs for early career researchers/students.</p> | <p><i>UM, Researchers/Staff: "And I think this is a very simple solution to open positions like for years, those people can do a full term in research under our guidance, mentorship. But then, of course, they don't promise full-time positions to them. That's how actually [researchers] in Europe or the United States work, and so we need more positions put to them where they can work full time."</i></p> |
| <p>Higher education institutions foster collaborations with industry to increase students' chance for employment.</p> | <p><i>UG, Students: "Although in this area it is easy to convince students to cooperate and to be involved in a project because they see the perspective because that (...) company might be a future job or something like that."</i> <i>UNIST, Students: "And for industry, I think it is important maybe to push things a little more to[wards] (...) the universities, to make some plan so they have to do some searching for us (...) So we can continue after college to work (...)"</i></p> |
| <p>Theme 3: Enhancing the social impact of research – delimitations between academia and society and ways of overcoming them</p> | |
| <p><i>Subtheme 1: Differing publication models and communication methods prevent research from reaching society</i></p> | |

| | |
|--|--|
| <p>No social impact due to specificity of scientific language or lack of public access to research</p> | <p><i>UM, Researchers/Staff: "It obviously is of great satisfaction to us, but that [research] will remain in a restricted domain, it will remain in a journal, it will remain in a paper, you might get cited. But it might give you some pleasure in seeing yourself having had an [scientific] impact, which ultimately is what counts. (...) But then there is another impact and there's the impact on society."</i></p> |
| <p>Delimitation between society and academia due to the stigma of the academic "ivory tower".</p> | <p><i>UM, Researchers/Staff: "...even though people look at university academics as the people working in their own bubble, trying to publish, obviously we are pushed to publish our work. But in the long run (...) all the inventions, all the ideas, political ideas, social ideas, they all came from a thinking group which are academics (...) So in the long run, it's because people cannot see the end of the work that they discussed."</i></p> |
| <p><i>Subtheme 2: Research "translation", "open science", and "useful science" as methods for disseminating research in society</i></p> | |
| <p>"Translating" research and creating new communication methods to society/policymakers can overcome barriers.</p> | <p><i>UM, Researchers/Staff: "Translate articles into popular articles for the general public in a way that they can understand (...)"</i> <i>UCA, Researchers/Staff: "(...) to be able to publish our results or to make more effort to make our results (...) arrive (...) to policymakers or institutions."</i></p> |
| <p>Students attracted to "impactful" and "useful" science and research.</p> | <p><i>UBO, Students: "The knowledge needs to be translated for the general public, otherwise it's too complicated (...)"</i> <i>UBO, Students: "And related to what SPEAKER 10 said, I think it's very important to do useful science and to be able to transform your results in something useful to the society."</i></p> |
| <p>Real-life application of research attractive to students.</p> | <p><i>UBO, Students: "I interacted with physicians and biologists (...) I was able to learn more about the application of my molecules and how to interact with other people."</i></p> |