# Valuing the contribution of research facilities (RFs) to education

# and

# their role in the postgraduate (PG) curriculum.

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# * ACKNOWLEDGMENTS *

# * ABSTRACT *

**PURPOSE**

The purpose of this research was to assess the contribution that research facilities (RFs) make to higher education, focusing on their educational value rather than in their contribution to research. Main elements of that contribution and its impact needed to be identified. Finally, the study also aimed at understanding the role of RFs for the education of postgraduate (PG) students and at identifying recommendations for recognising the educational role of RFs at the University of Sheffield.

**DESIGN/METHODOLOGY/APPROACH**

The research used a mixed approach to collect quantitative data from which qualitative interpretations could be done. The research tools to collect these data consisted of a RF logbook to gather data about educational activities carried out in RFs, including information about required resources, and a questionnaire for RF's users to gather information about the impact that those activities had in users who were involved. A non-probability purposive sampling was used to recruit participant RFs from the Faculty of Science and users of participating RFs. Data was collected for a consecutive period of six weeks.

**FINDINGS**

The research identifies RF as active and valuable educational environments and having an essential role in research projects of RF users, in their learning and in enhancing their employability. It opens the discussion of considering RFs as strategic learning partners in the landscape of PG research education and their potential as spaces for the development of communities of practice.

**ORIGINALITY/VALUE**

This is the first study to show evidence for the quantity and quality of the educational work carried out in RFs, offering a new perspective about the role of RFs as active educational environments in higher education institutions, with particular implications for PG research students.

**KEYWORDS**

Research facilities, postgraduate higher education, research-teaching relationship, non-academic staff, non-formal education

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# * 1: INTRODUCTION *

This dissertation comes from a personal enquiry about the way in which I have ended up developing my own role at the University of Sheffield, for which I did not have any previous experience or training and consisted on a "non-academic" blend of research and education; I am the manager of a mass spectrometry research facility (RF) in the Faculty of Science, i.e.: a specialised laboratory space where analytical mass spectrometers and other resources for sample treatment and data analysis are available for their use in research. Thus, I have attempted to shed some light on the relationship that research and education have in RFs; spaces that originate because of their link to research but have also become nests of fruitful teaching and training. The absence of studies about research and education in RFs highlights, on one side, how little is known about their practice and impact in higher education institutions, and on another, a potential lack of interest in understanding and valuing the complex work that RF staff (mostly professional staff) carry out to support research and the education of PG students through non-formal learning. As a result, RFs are a neglected area of study (and understanding) in higher education research.

When I started my position more than 3 years ago, I realised that most users were PhD students and quite early I noticed that I was spending a significant amount of my time "explaining things" to them, so they could learn and understand what the technique was about, the best way of preparing samples and how to have a look at the results from a critical perspective. This interaction with users is very much collaborative and synergistic, a two-way interaction where they also need to "explain things" to me, so I can learn and understand what their projects are about, what their objectives are and what the best way is to approach them with the resources in the RF. I was developing a manner of working based on communication and understanding with the objective of maximising the quality of the research outputs. So, somehow, I perceived research and education in a RF as two intimately related sides of the same valuable coin. However, no one told me that I had to be so engaged in training users, I could have developed the RF exclusively as a service and no one would have accused me of bad practice by doing so. So, I was not sure that the education of users was recognised by the institution as an important part of my job. Many questions arose then: am I doing a good job? Why is this educational work not recognised? Is it really beneficial or is it just my impression? Shall I be spending less time educating and understanding users and their projects so I can analyse more samples and generate more income? I must admit that I consider myself a very sociable person and those interactions with users are the most rewarding part of my job. So, could it be that I am dedicating "too much" time and energy to this because it is what I enjoy the most? Another question that I have had for a long time was: if this educational part of my job is not

recognised, does it mean that other RFs work in a different way? If so, how do other members of staff and students perceive the role of RFs? I still do not have the answer to all of these questions, but I already started to explore some of them in the research project of the last MEd module (Acosta-Martin, 2019). I had a look at how important (scale from 1 to 5) the role of RFs was for PG students and staff in the Faculty of Science in terms of funding, teaching, engagement, and research. Findings from this preliminary study showed that, considering responses for all possible roles for RFs (**Figure 1.1**), 62% of responses gave RFs a degree of importance 4 and 5, 23% were neutral (importance 3) and 14% gave RFs an importance of 1 and 2.
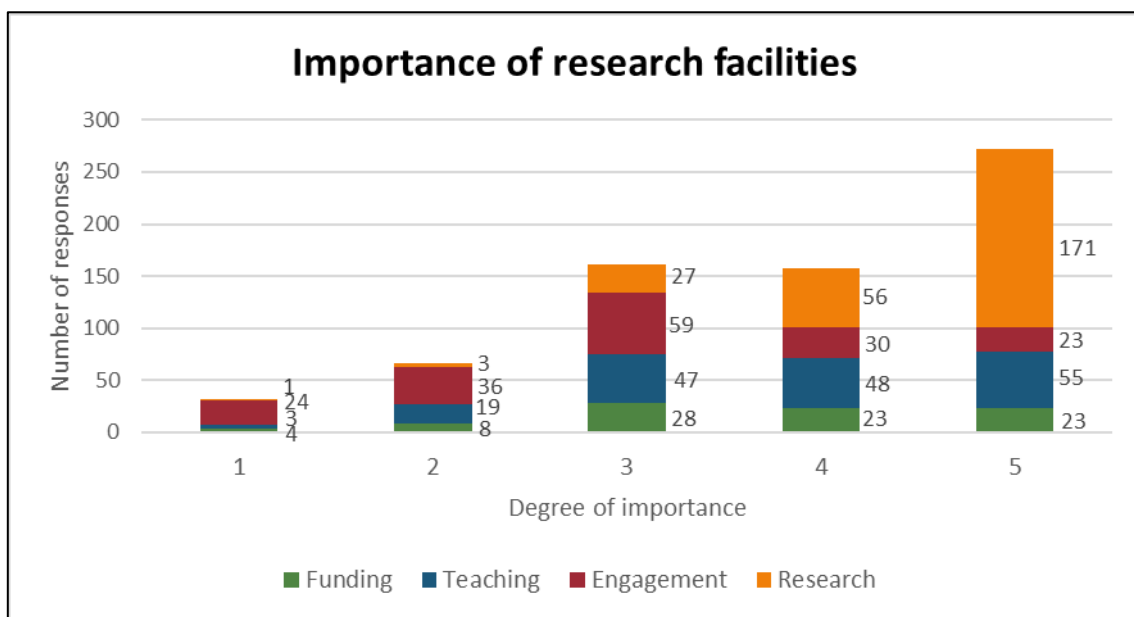


**Figure 1.1. General importance given to RFs in the Faculty of Science.** Number of responses falling into each degree of importance are represented for funding, teaching, engagement and research. Figure and legend taken from the fourth MEd portfolio (Acosta-Martin, 2019).

The most important role attributed to RFs was in research, followed by teaching and then funding, while their least important role was in engagement. RFs were given similar importance by academic staff, professional/technical staff and PhD students. These findings suggested that RFs are also perceived as playing an important role in education, and most qualitative answers from respondents giving a high importance justified their choices by making connexions with PG education and research. Illustrative examples of such justifications given in questionnaire responses are shown in **Table 1.1**. This preliminary study was an important first step towards the understanding of my own role as RF manager and how I was aiming to develop the RF. It also helped me to corroborate the perception that I have of my own role through the perceptions of students, academics and other members of the academic community at the Faculty of Science.

| | Justification for giving RFs a high level of importance in teaching and training |
|---|---|
| **Importance 5** | ✓ *"Essential skills for undergraduates and postgraduates. Especially given the importance of the skills listed above to modern science"*<br><br>✓ *"Students can use state of the art facilities and this can give them a sense of ownership of their career."*<br><br>✓ *"PGRs couldn't be trained properly without these."*<br><br>✓ *"Members of these research groups are likely experts in their field and could give guest lectures on their topics of speciality"*<br><br>✓ *"Most if not all of these facilities have managers whose role includes training of users. This is vital to making the best use of these facilities."*<br><br>✓ *"To attract the best students -- especially for postgraduate programmes --, we need to provide modern and well-equipped facilities so they can get the best training possible."*<br><br>✓ *"This is one of the ways of passing on knowledge and provides a platform to learn new things. Also necessary for advancement of science"*<br><br>✓ *"A University is a learning environment and we should strive to be educating the next generation at every opportunity."* |
| **Importance 4** | ✓ *"For nurturing future waves of scientists"*<br><br>✓ *"We are a university so this is important"*<br><br>✓ *"The facility teams are very well trained in their specialities and they are a good place to learn from"*<br><br>✓ *"Training of new users is paramount to run the facilities in the most efficient manner"*<br><br>✓ *"The facilities offer the chance to learn and use specialised equipment which will benefit PhD students in their future careers"*<br><br>✓ *"I've learned a lot of new PhD skills from these."* |

**Table 1.1. Justification for giving RFs a high level of importance in teaching and training.** These data were collected for the research study carried out in the fourth MEd portfolio (Acosta-Martin, 2019).

Keeping all the above in mind and moving on into a deeper level of understanding, I am presenting here my dissertation project about the contribution of RFs to education and their role in the PG curriculum. This work aimed at assessing what is the educational contribution of a diverse group of RFs in the Faculty of Science in order to enhance their value as active educational environments. The evaluation of such contribution has been tackled from two complementary points of view: 1) which RF resources are used for educational purposes and 2) what the benefit of this educational activities is for RF users. This information is also complementary because both parts

involved in these educational interactions, i.e., RF staff and users, participated in the study. This piece of research offers new empirical evidence to support the value of RFs through the contribution that they make to education. Given that most RF users are PG students, I have discussed the findings from a perspective that allows RFs to find their place in the PG curriculum, helping both RF staff to be recognised for their work and PG students for what they have learnt in RFs. To the best of my knowledge, this is the first time that the concept of RFs is approached from an educational perspective, challenging the reductionist vision of RFs as instrument driven research factories.

In the following section, I explore the literature about the relationship between research and teaching in research-intensive universities, provide a brief introduction to RFs, and some background about the education of PG students in such universities. I also present here the research questions. In section 3, the methodological approach used for the study is explained in detail, which combined the collection of two separate datasets: one from RF staff about educational activities and resources, and another from RF users about their perception of educational activities. In section 4, findings arising from the analysis of collected data are presented. Section 5 includes the discussion of these findings from a more global perspective and considering their implications. Limitations of the study are also discussed. Finally, main conclusions of the research are summarised in section 6.

# * 2. BACKGROUND & LITERATURE REVIEW *

Literature about the nature of RFs, how they work and their different roles in higher education institutions is very limited. Therefore, I have preferred to use this section to develop a mix between traditional and scoping review (Jesson, Matheson and Lacey, 2011) to provide some background and set the scene for the study by focusing on 1) research-intensive universities and the relationship between research and teaching in these universities, 2) the origin of RFs and the different ways to access them, and 3) the education of PG students in research-intensive universities. Throughout these themes, I paid most attention to the situation in the UK. However, when relevant, literature originated in or referred to other countries. Finally, the research questions of the study are formulated.

## 2.1. RESEARCH-INTENSIVE UNIVERSITIES AND THE RESEARCH-TEACHING RELATIONSHIP

The importance and role of research-intensive universities for modern societies have been recently highlighted in a report from the Group of Eight, compose of eight leading research-intensive universities in Australia (Group of Eight, 2013). In this report, the role of research-intensive universities is discussed from the perspective of education, research, storage of knowledges and capabilities, innovation, reputation and international networks, and of their economic and social mission. It concludes that research-intensive universities are fundamental elements in any national innovation system and that they help the system, including government, business and other universities, to set the highest possible standards of performance and to provide possibilities otherwise not available to achieve a better future (Group of Eight, 2013). Together with this, active research environments can have a significant impact in how other areas of higher education progress, particularly teaching of undergraduate (UG) students and training of PG students. Thus, from an educational point of view, research-intensive universities also declare beneficial the presence of the research environment for students' learning experience. For example, the Russel Group, comprising 24 leading research-intensive universities in the UK and including the University of Sheffield, mentioned in a recent report the following key advantages of research-intensive learning environments (Russell Group, 2017): a cutting-edge curriculum informed by the latest research, the development of students as active researchers and highly skilled graduates, the access to world-class infrastructure and equipment, and the application of research findings to inform pedagogical approaches. These reports from the Group of Eight and the Russell Group, possibly written to promote the quality of their universities and attract new student customers are inspired on idealistic conceptions of the relationship between research and teaching, as none of them makes reference to research studies in order to support these claims,

although at least, the report from the Russell Group briefly describes some examples of practice in associated universities. However, while in theory all these arguments make a lot of sense, in practice, academic staff in research-intensive universities find that a balanced commitment between quality teaching and excellence research is increasingly difficult to achieve (Rowland, 1996; Mahlangu and Victor, 2014; Mitten and Ross 2018). The quality of research outputs and the number of high impact publications have become a priority for such institutions, where prestige and funding depend directly or indirectly on those factors rather than on the quality of the education that they provide. Student satisfaction and evaluation of teaching also have an impact on these factors (Bell and Brooks, 2018), but it is not necessarily related to the quality of the education received (Uttl, White and Gonzalez, 2016; Stroebe, 2016). Driven by these research related priorities, recruitment of academic staff is often based on their excellence research and little attention is paid to their pedagogic capabilities. Thus, these external pressures for research outputs and excellence may compromise the quality of education and have a negative effect on the relationship between research and teaching (Jenkins and Healey, 2007).

Numerous authors have studied this intricate relationship between research and teaching from different angles and focusing on the learning of UG students (Light and Calkins, 2015; Freestone, 2004; Levy and Petrulis, 2012; Brew, 2012). The concept of teaching seems to be of exclusive use for UG education and supervision is usually applied in PG research programmes. In both cases, students remain students and go through a transformative learning experience. The transition from UG to PG education represents a challenge in many senses. I approached this transition in my first portfolio (Acosta-Martin, 2018a) where I addressed it from different aspects like *teaching and learning*, *identities*, *massification*, *quality assessment* and *diversity*. I described it as an isolation process inherent to the higher education system and independent from the student's feelings. I also added empathy as a key factor that could soften that transition and help PG education be the mirror of more dreams and less nightmares. Because of the change in scenery and terms to articulate PG education, very few authors have looked at the relationship between "*teaching*" and research from a point of view that included PG students. One example of this group of studies involving PG education and having a look at the association between research and teaching describes the development of a part-time MEd programme (Rowland and Barton, 1994), which is indeed the one for which I am writing this dissertation. The programme was developed for staff at the University of Sheffield in order to increase the quality of teaching across the institution. In this context, university staff becomes PG students to improve their teaching skills and encourage reflexion about higher education systems and their role within the university. In general, the content of the programme focuses on the teaching and learning of UG students, although the flexibility of the programme allows the addition of PG-related content

based on the interest of participant staff. From my own experience, this programme really helps in developing a wider understanding of learning and teaching in higher education and put that understanding into a more practical context through the final dissertation project that we need to carry out in order to achieve the degree. We are highly encouraged to relate this project to our own professional role within the institution. An important improvement of the programme compared to its original description in the paper is that currently it is not only addressed to academic staff, but also to university staff in professional roles (which is my own case), acknowledging the fact that professional staff can also be holding more academic responsibilities involving the support of student learning.

Another relevant example explores the relationship between research and teaching in doctoral education from the perspective of PG students and across the UK (Chiang, 2011). In this study, teaching was assessed from the perspective of the PhD students' learning experience, including supervision and research environmental factors. Research was assessed by the scores of the Research Assessment Exercise (RAE) in 2001. The author considered disciplinary differences and selected Education and Chemistry departments as representative subjects of social and natural sciences. Twenty-eight Education and 31 Chemistry departments participated in the research, which concluded that while there were disciplinary differences in research training structures (individualism in Education *vs*. teamwork in Chemistry) and student's perceptions of doctoral education (more favourable in Chemistry than in Education), there was an absence of significant relationship between research and teaching for both subject matters. Interestingly, amongst research environmental factors included in the study, students were asked about RFs and this is how Chiang described the findings:

> *"The striking fact in Table 7 is the disciplinary variations in research facilities. First, the 2001 RAE has a negative relationship with research facilities in Education, but it has a positive relationship in Chemistry. Second, it is only in Education that research facilities are less favourably perceived by Far East Asian students than other students."*

Chiang related this difference to the difference in disciplinary training structures: teamwork *vs*. individualism. The teamwork structure in Chemistry offers more open and integrated environments where researchers and students interact and share resources. On the contrary, in the case the individualistic nature of research in Education, while RFs are accessed and utilised by research staff, the absence of resource sharing makes students have a more limited use. In this way, this study highlights the role of RFs as important factor for PhD student's experience and their perception of a positive learning environment. In my own experience as PG student in both areas Chemistry and Education, I can confirm these singularities in training structures for each discipline. Being used to

teamwork, I found it difficult to embark on an individualistic research environment. Luckily, by involving other RFs in this project, I have minimised the level of individualism and managed to feel that I was rather working within a team.

To summarise, the relationship between research and teaching in research-intensive institutions is a complex and often unbalanced interaction. In practice, this interaction is mostly dominated by a compartmentalised view in which research is perceived as such, and teaching as purely UG teaching. Broadly speaking, despite PG education is the indisputable meeting point of teaching with research, this interaction has been rather studied as how academic research can be used to enhance UG teaching and vice versa.

## *2.2. A BRIEF INTRODUCTION TO RFs IN RESEARCH-INTENSIVE UNIVERSITIES*

In this context, RFs are laboratory spaces where specialised analytical instrumentation or other resources are made available for the purpose of research. Even though large pieces of equipment and resources have always been used for research, the grouping and sharing of equipment in RFs has been a relatively recent practice. During my international trajectory over the last couple of decades, where I have been immersed in scientific environments across 5 countries, I have witnessed how the number of RFs in higher education institutions and research organisations have progressively increased. Nowadays, RFs are quite common sources of research equipment and resources across engineering and the natural sciences. In the UK, motivations for this development were based on increasing the efficiency and sustainability of research, by reducing the amount of duplicated equipment and the implementation of new costing models (Jackson, 2013). On the one hand, UK Research and Innovation, bringing together Research Councils, Innovate UK and Research England, has largely contributed with funding to the creation of such RFs and the incorporation of new technologically competitive state-of-the-art equipment to the research assets' catalogue of higher education and research institutions (Research England n.d.; EPSRC n.d.; BBSRC n.d.). On the other, regional collaborations amongst most research-intensive universities have given rise to groups like the N8 (Durham, Lancaster, Leeds, Liverpool, Manchester, Newcastle, Sheffield and York), the M5 (Aston, Birmingham, Leicester, Loughborough, Nottingham and Warwick), the SE5 (Cambridge, Imperial, Oxford, Southampton and UCL) and the GW4 (Bath, Bristol, Cardiff and Exeter), which with the help of research councils have promoted initiatives and facilitated the sharing of equipment and the development of RFs (Georghiou, 2012; Jackson, 2013; Georghiou and Jackson, 2014).

In general, researchers at all stages of their careers can access RFs in two ways: as a service, in which case RF staff will run the analysis required by the researcher; or as direct users, being

themselves in charge of manipulating the equipment and running their analyses. Despite the fact that in both cases charges are applied for accessing RFs, in the latter scenario, the access to RFs comes together with dedicated training sessions in order to make sure that users manipulate instruments and resources adequately in addition to interpret the results appropriately. As part of the implementation of equipment sharing, the N8 Research Partnership developed a framework with a set of guiding principles and templates in the following areas: Health & Safety and Training, Pricing and Charging, VAT, and Contracts and Legal (N8 Research Partnership, 2014). As a result, the training of RF users has been given recognition as one of the key elements to be considered to enhance efficiencies and ensure effective usage of research instrumentation in RFs. However, little, if any, attention has been paid to the practical implications of carrying out such training. In fact, the training of RFs' users can represent quite a significant amount of non-formal education carried out by RFs' staff, and I want to emphasize the notion of non-formal here because this concept have also been a source of questioning at the origin of this project. In this respect, learning can be classified into three main categories: *formal*, *non-formal* and *informal* (Coombs, Prosser and Ahmed, 1973; Dib, 1988; Ainsworth and Eaton, 2010; Manolescu, Florea and Arustei, 2018).

| | CORE CHARACTERISTICS |
|---|---|
| **Formal learning** | ✓ Intentional.<br>✓ Arranged within an education/training system or the workplace.<br>✓ Organised and defined as an explicit learning activity with defined learning objectives.<br>✓ Rather long and/or full-time activity.<br>✓ Usually leading to a qualification. |
| **Non-formal learning** | ✓ May or may not be intentional.<br>✓ May or may not be arranged within an education/training system or the workplace.<br>✓ Somehow organised but not designated as a learning activity with defined learning objectives.<br>✓ Rather short and/or part-time activity.<br>✓ Usually not leading to a qualification and where formal credits are not granted. |
| **Informal learning** | ✓ Not intentional.<br>✓ Rather spontaneous and happening everywhere all the time.<br>✓ Not organised.<br>✓ Its duration is not defined.<br>✓ Not leading to a formal qualification. |

**Table 1.2. Main characteristics of formal, non-formal and informal learning.** Adapted from Werquin (2007) and Ainsworth and Eaton (2010).

A fourth category *semiformal* has been proposed (Werquin, 2007) but not embraced and further utilised by the educational community, so I will not mention it in more detail. The core characteristics defining each of the three main categories can be summarised in **Table 1.2**. By having

a look at this classification, the training of users in RFs falls perfectly into the category of non-formal learning. I actually wonder whether PG research learning in general can be also classified as mostly non-formal.

In summary, the promotion of RFs and the sharing of equipment in higher education institutions in the UK have their origin in governmental plans for research efficiency and sustainability. RFs can be mainly accessed in two different ways: as a service or as direct users. The latter type of access requires the training of users by RF staff and this training develops in the shape of non-formal education.

## 2.3. STUDENT LEARNING IN PG RESEARCH EDUCATION

The diverse and specialised nature of PG programmes, even within the same discipline, make difficult the task of implementing structural guidance. Taught master's programmes are more similar to UG programmes and benefit from a more defined and structured curriculum, while research master's and PhD programmes are more flexible and suffer from this lack of structure and theoretical learning previous to practice. Barnacle and Mewburn (2010) describe this phenomenon quite well: "*… the practices of research are not learnt theoretically or in advance to be exercised ... Rather, learning … and how to do research occur through the activity of doing research*." As a consequence of this, the education of PG research students is defined by multiple factors through participating in the research process. From these factors, the relationship with their supervisors is possibly the most influencing one and I discussed the importance of this relationship in my third MEd portfolio (Acosta-Martin, 2018b), placing it together with employability as the main components of the PhD curriculum. Following Chiang's (2011) classification of research training structures (individualism *vs*. teamwork), the influence of the supervisory relationship on the learning experience will be greater in subjects like Education with a more individualistic research structure than in subject like Chemistry with teamwork structures, where PhD students can interact with and learn from other members of the group. One way of including more teamwork in PG research degrees in the social sciences is by the implementation of cohort-based supervision. In this model of supervision, a cohort of students sharing a common research area or theory is assigned to a single supervisor or a supervisory team with complementary expertise (Choy, 2015). The basis for learning cohort development is informed mainly by the theory of social constructivism concept of *community of practice* (Fosnot, 1996 and Leave and Wenge 1991, cited by Choy, 2015). By working with a small cohort of students enrolled in an Australian MEd research programme, Choy develops an approach to how to develop this "teamwork" environment through four provisions: 1) initial residential workshop, 2) development of a learning community, 3) nourishing scholarship, and 4) ongoing learning opportunities. The implementation of

these provisions developed a culture and environment that was very nurturing and supportive from the perspective of the students. In another study (Shacham and Od-Cohen, 2009), a doctoral programme developed in collaboration between the UK and Israel, incorporating communities of practice is proposed as a model of adult learning and professional development. Four main components of the communities of practice, conceptualised and structured around learning engagement, development and sharing, were used to develop the doctoral program: 1) learning in cohorts, 2) conducting group workshops, 3) engaging guardian supervisors, and 4) conducting research workshops and self-help groups. Additional studies in the UK (Meschitti, 2019) and the US (Flores-Scott and Nerad, 2012) taking into account the larger environmental context of research, emphasised the importance of peer learning amongst PhD students. Although providing a shared space is central to make these interactions happen resulting in the further development of learning communities, the nature of this shared space does not need to be physical, i.e., a room. Some communities of PhD students use social media platforms, such as facebook, Instagram, linkedIn, pinterest or twitter, to create, develop or enhance their learning and to support each other (Johson et al., 2017). Overall, these studies encourage institutions to consider the development of such learning communities as part of their PG research programmes, which allows enhancing the learning of research skills and opportunities for personal development. Furthermore, promoting the development of communities amongst PG students could decrease feelings of isolation and loneliness while the interaction with other PG students appeared beneficial for their development as scholars.

In the natural sciences, where laboratory spaces are regular scenarios where teamwork research develops, learning interactions occur in even more complex ways and in a diversity of situations. Vekkaila et al. (2012) performed a study aiming at exploring key learning experiences of doctoral student in the natural sciences in a Finish university. They identified three major elements: 1) academic communities of practice including their own local research groups and more global networks are important for the students' learning and development, 2) significant learning experiences take placed in everyday practices like research work or academic meeting, and 3) research instruments and facilities are important for students' learning and researcher development in the domain of "big science". A more specific study had a look at multiple learning relationships of PhD students in Biomedical Science in the US and the UK (Kemp et al., 2014). This study concluded that technical learning is mostly facilitated by interactions with postdoctoral researchers, other students and technical staff, empathetic emotional support was mainly facilitated by interactions with other PhD students, and coordination, confidence and funding were the most valuable aspects of their relationship with supervisors. These two studies are valuable examples for the need of having a look at the wider picture of research interactions in the study of PG student learning. Paying attention at

these other elements, changes benefiting the learning experience of students could be implemented in PG research programmes.

Another interesting way of integrating all interactions influencing learning of doctoral students in a research environment draws on the actor-network theory (Barnacle and Mewburn, 2010), whereby the journey of becoming a doctor is affected by other people and objects in a network of interactions. In this study, PhD student relations can occur with other *knowers* like the supervisor, peers and other members of the network, and with *knowledge artefacts* like journal papers, books, instruments and other objects. Barnacle and Mewburn argued that while administrations provide prescriptive lists of generic skills developed as part of doctoral programs, these come without advice on how the learning of such skills might be achieved. The actor-network theory offers a beneficial way of understanding doctoral learning by paying attention at all elements involved in the process, which could help in the implementation of research pedagogies and better support the learning of PhD students.

Traditionally, the study of student's learning in PG research programmes, particularly in doctoral programmes, has been reduced to the study of the supervisory relationship (Acosta-Martin, 2018b). More recently, the impact of the relationship with other elements, such as other students, postdoctoral researchers and technical staff, material resources, research facilities and infrastructures has also been taken into account. By doing this, the academic community and higher education systems are acknowledging the complexity and uniqueness of the learning process for individual students in research environments. The promotion of communities of practice seems beneficial for the learning process, but there are still many other factors that need to be researched and understood.

## *2.4. AIMS AND RESEARCH QUESTIONS*

The current research had two major aims. The first one was to assess the educational contribution that RFs made in higher education institutions and the second one was to understand what the role of RFs could be in the PG curriculum. In order to achieve the first aim, I formulated the following research questions:

**QA.** What resources in RFs are used for education-related activities?

**QB.** How beneficial are these education-related activities for the users of RFs?

**QA** is a descriptive research question, while **QB** could be considered as a rather evaluative research question (Matthews and Ross, 2010). Answering them had certain practical considerations. Because of my own experience, I knew that limiting the study to the RF where I work, will provide

specific findings about my own practice and will make these findings biased towards a high proportion of educational activities with a potential increased perception of benefits for users. So, if I wanted to achieve a wider overview of the educational scene in RFs, I needed to include in the study as many RFs as possible, but of course within a manageable number. Another important consideration was that I needed information from the two types of actors taking part in educational activities: RF staff to address **QA** and RF users to address **QB**.

I have devoted my third MEd portfolio (Acosta-Martin, 2018b) to the PG curriculum, which has proven to be quite a complex issue. So, to achieve the second aim was realistically a task that could use a whole research project on its own. I have been less ambitious and by focusing on the findings related to PG students, I developed ideas to open a discussion and reflect upon the role that RFs could play within the complexity of the PG curriculum.

# * 3. METHODOLOGY *

## 3.1. RESEARCH PARADIGM: ONTOLOGY AND EPISTEMOLOGY

The research paradigm that I adopted to investigate the above stated research questions was a combination of post-positivism and interpretivism (Matthews and Ross, 2010) as I assumed that understanding the contribution of RFs to education had an objective and a subjective component (Della Porta and Keating, 2008). The underlying hypothesis behind those research questions was that there is, indeed, a contribution. RFs, as defined in this study, operate within research environments in higher education institutions and it seems reasonable to assume that subunits of an educational structure would also have an educational role. However, the extreme complexity of the higher education system, not only devoted to education but also driven by economic and research ambitions (Rowland, 2002), where students are increasingly perceived as customers (Bunce et al., 2017; Cantwell, 2015), makes of that assumption a probabilistic or even circumstantial fact rather than a categorical statement. I believed that the contribution of RFs to education could be *measured* by having a look at 1) the resources utilised for educational purposes in RFs and 2) their impact from the point of view of RFs' users, recipients of such an education. While I viewed the resources involved in education, for example time and materials, as tangible pieces of information, and therefore relatively easy to be captured, I understood that the impact on users depends on their personal experiences and circumstances, including how they perceive the interaction with RFs' staff. Thus, knowledge about the impact is subject to interpretation from their perspective and from my own perspective as researcher. Based on this, I decided to use two separate methods for data collection (one for resources and one for impact) that were able to capture objective data (quantitative information), but could also be used to draw more subjective conclusions (qualitative information), particularly in the case of the impact on users. On top of having a look at resources and impact, I aimed at making a deductive relationship between them, but only after framing the study in the context of its development and after validating that the link between gathered information was plausible. Finally, I just did not assume that RFs do contribute to education but also that, as a consequence of being framed by a research environment, they could play a dedicated and recognised role in the PG curriculum. Finding and defining this role seemed to be an interpretivist exercise strongly influenced by the views of RFs' staff involved in the study and, of course, by my own experiences as RF manager.

## 3.2. POSITIONALITY

I am the Biological Mass Spectrometry Facility Manager for proteomics applications at the biOMICS facility in the University of Sheffield since April 2016. Before this, I went through a classical academic path of achieving a Master's, a PhD, and a couple of postdoctoral positions. When I started this position (this time as part of the professional staff), the perception that I had about the RF was centred around contributing to the success of multiple research projects requiring the use of mass spectrometry for the analysis of relevant proteins and peptides. This perception is still up to date, but its practicalities have implications on my own role that go far beyond being in charge of just analysing proteins and peptides. Being more precise, my role can be briefly described as being responsible for all aspects of the facility for its required function, including administrative, financial, technical, educational and research related aspects. One of these aspects that became rapidly the focus of my daily activities was the training of users in sample preparation, analysis and data interpretation. The simple fact of training RF users together with the experiences that I gathered during those training interactions were amongst my motivations to enrol in this MEd course and to focus my dissertation project on the contribution that RFs have to education.

More precisely, my interest in this project has been driven by wanting:

- To have a better understanding of my own role in which I am applying and developing educational skills in a research environment.
- To gather evidence for the educational work carried out in RFs so we can be appropriately recognised.
- To make a more cohesive network of RFs' staff, which will help defining our identity.
- To increase the support given to RFs' staff, including more opportunities for professional development.
- To improve the support to our users and their learning when they use RFs.

These motivations have affected the way in which I developed the research study, including the definition of research questions, widening the scope to other RFs instead of limiting the study to the RF where I work, organising several meetings with my peers from participating RFs so we could know each other and create bonds to facilitate future collaborations and interactions to continue this project after the framework of the MEd, proposing ways of recognising this educational role of RFs, or promoting the improvement of RF staff professional development in order to improve the support given to users.

## 3.3. METHODS

I have explored different ways of answering research question **QA**. in my second portfolio (Acosta-Martin, 2018c) by suggesting four different procedures to assess the contribution that RFs make to teaching (teaching has evolved into education in the current research project): 1) *the simplest way* (generation of a list of educational activities with descriptive data collected in RFs), 2) *the simplistic way* (asking PG students, as part of their paperwork before graduation, which RFs they used and how that use contributed to their research projects), 3) *the user questionnaire based* (asking RF users about their knowledge acquisition and learning every time they use a facility) and 4) *the use of formative assessment* (evaluation of the RF user's learning progress every time they use a RF). However, because none of these procedures provides a general and integrated overview that would include the information required to answer both research questions **QA** and **QB**, I have decided to use two complementary and interdependent methods, one for each question. Question **QA** is descriptive and **QB** is rather evaluative, so I aimed at collecting datasets containing mainly quantitative information, and from which I could also derive qualitative interpretations. Both datasets would originate in participating RFs as follows: RFs' staff would record information in a logbook to address question **QA** (use of resources) and would ask users to provide their email addresses so they could be sent a questionnaire addressing question **QB** (impact). I designed both the logbook and the questionnaire in a way in which data could be collected using computer-mediated communication (Matthews and Ross, 2010).

### 3.3.1. RF'S LOGBOOK DESIGN

The design of the logbook was based on *the simplest way of assessment* (Acosta-Martin, 2018c). Before I defined its content, I had a preliminary meeting with RF managers showing an interest in participating in the study in order to understand the diversity of activities that were carried out in each RF. By doing this, I wanted to design a tool that could collect that diversity of information and that was applicable by all participants in a simple and low time-consuming way. Data about RFs resources used for educational purposes included three main types of information (**Table 3.1**): **A**) about the kinds and quantity of users benefiting from the activity, **B**) about the characteristics of the educational activity, and **C**) about the quantity of staff, time and major instruments used for the activity. Activities registered in logbooks were limited to those in which there was an educational interaction between RF staff and RF users during the data collection period. In this context, the concept of educational interaction was defined as a two-way interaction between RF staff and RF users involving any kind of practical or theoretical teaching, training, or explanation of RF related

knowledge. Therefore, this limitation implied that the use of a RF by users trained in the past and currently using the RF independently was not registered in the logbook. However, these users were asked to participate in the study through the questionnaire as I will explain in the following section (**section 3.3.2**).

I created a Google Sheets file for each participating RF and shared it with individuals in charge of data collection, so each RF had access exclusively to their own information while I had access to data tables from all of them. The initial files contained instructions for data collection as well as examples of data in order to facilitate the task for individuals in charge of data collection. A copy of the initial Google Sheet without collected data can be accessed by clicking here (headers of the Google Sheet are shown in **Appendices 8.1**).

| | LOGBOOK INFORMATION | DETAILS |
|---|---|---|
| **RESOURCES** | **Participant users' profile** | ✓ Amount<br>✓ Status |
| | **Educational interaction description** | ✓ RF where it took place<br>✓ Type of interaction<br>✓ Description of the content<br>✓ Formality / Officiality |
| | **Resources used** | ✓ Staff<br>✓ Preparation time<br>✓ Duration time<br>✓ Equipment |

**Table 3.1. Information collected in RF's logbook.**

In addition to the information about resources, RF staff were instructed to ask all trained users for permission to send them an email with the questionnaire. Email addresses of those users were included in a separate spreadsheet of each Google Sheets file.

### 3.3.2. USER'S QUESTIONNAIRE DESIGN

In order to understand how beneficial these education-related activities were for RFs' users, the *user questionnaire based assessment* (Acosta-Martin, 2018c) was used as a starting point. However, instead of focusing on the acquired knowledge and learning of RF users, I rather took into consideration the content of my third portfolio about the PhD curriculum (Acosta-Martin, 2018b), which identified two main aspects of the PhD curriculum: supervision and employability, and included these aspects as part of the questions in the survey.

The user's questionnaire was structured into two sections (**Table 3.2**): **A)** user profile (institution, department and status) and **B)** perception about his/her interaction with the RF. Section **B**) listed RFs that participated in the study and contained four questions: one of them was about the kind of educational interaction that the respondent had (working on experimental design, theory, instrument use, results interpretation, or none), and the other three were about how important/beneficial the interaction was, making reference to the above mentioned aspects of the PhD curriculum: *How important is the use of this research facility for your project?*, *How important is the support of research facility's staff for you?*, *How beneficial is the use of this research facility for your professional future?* The two first questions were related to supervision while the third one was related to employability. I considered the use of open questions for this section but finally decided not to use them because of the complexity in data analysis and my limited time and experience in the analysis of qualitative information. Therefore, I formulated multiple choice or check questions with closed answers. In particular, for the three questions about how important/beneficial the interaction was, respondents had to select a degree of importance (not important/beneficial, somehow important/beneficial, and very important/beneficial) that was followed by an explanatory statement. The use of additional statements provided useful information to interpret the results in a more qualitative way.

| | QUESTIONNAIRE SECTION | DETAILS |
|---|---|---|
| **IMPACT** | **Users' profile** | ✓ Status<br>✓ Department<br>✓ Institution |
| | **Users' perception** | ✓ Content of educational interaction<br>✓ Importance for the research project<br>✓ Importance of RF staff support<br>✓ Benefits for their professional future |

Table 3.2. Information collected in the user's questionnaire.

The questions were transferred into a Google Forms questionnaire accessible by an electronic link in an invitation-to-participate email that was sent to the list of users collected in the RFs' data. Examples of emails to first time and repeated participants can be found here (**Appendices 8.2**) and here (**Appendices 8.3**), respectively. The final questionnaire can be accessed by clicking here (questions also shown in **Appendices 8.4**) Responses to this questionnaire were collected anonymously.

## 3.4. TRIANGULATION

Triangulation is a measure of research quality by which different types of data are collected to address the same research question, so each set can be used to check the findings from the other (Matthews and Ross, 2010). Even though both the logbook and the questionnaire were tailored to answer different research questions, they had common elements. First and foremost, data collected by both methods were essentially generated from the same educational interactions between RFs staff and RFs users. Additionally, both methods considered information about the profile of users and the content of the different educational activities. These commonalities in the data gathered from the two sources (RFs *vs.* users) were used for triangulation, and therefore for checking the validity of the two sets of collected data.

## 3.5. IMPROVEMENT OF DATA COLLECTION TOOLS

Initial versions of the RF's logbook with example data, and of the user's questionnaire were shared in the briefing meeting with RFs' staff participating in data collection in order to discuss improvements and agree on the content. It was very important to me that my peers from other RFs were not only subjected to study but could participate in the design and further discussions about the final output and impact of the project. By offering these possibilities I intended to increase the power and the significance of the study.

RFs' staff provided feedback about the content of the data collection tools and these were modified accordingly in order to be more accurate and useful. An example of modification was the addition of a "Additional comments / Absence" field in the logbook to record lack of activities or additional comments that could be useful in the interpretation of the data. Another example, made to the users' questionnaire, was the suppression of a question asking which RF was used. RFs' staff revealed a certain degree of concern about being judged by the results of the study in the future. By removing this question there was no direct association between the RF that provided an educational activity and the user's perspective. This modification affected the level of detail in collected data but did not impact on answering research questions on the overall picture of how RFs contribute to education.

A verbal agreement was reached during this meeting: data collected from all RFs would be pooled and analysed together, so there would not be comparisons amongst the different RFs. One of the reasons to accept the above mentioned changes and this agreement was based on the focus of

the study to value the contribution that RFs make to education and not to evaluate how different is that contribution across RFs.

Finally, with the help of my peers, I designed a schematic workflow with the classification of all kind of users that we have in RFs and which of them should be taken for consideration in the study (**Figure 3.1**). The workflow was distributed to all RFs before the start of data collection.

Therefore, in spite of not having the time to pilot this study to improve my research tools, by open the discussion with participant RF staff, I did try to make sure that I was applying valid and reliable methods.
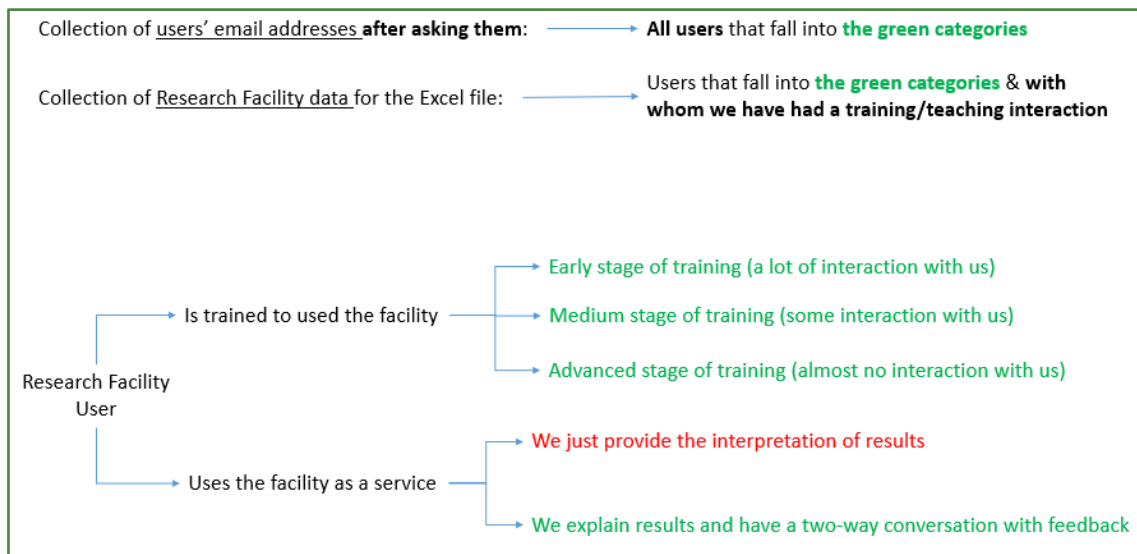


**Figure 3.1. Data collection workflow for RFs' staff**. Schematic classification of RF users to facilitate data collection tasks. There are basically two types of users, the ones that are trained and could become independent in their use of the RF, and the ones that use the RF as an analytical service.

## 3.6. SAMPLING

I used a non-probability purposive sampling technique (Denscombe, 2014) in order to select both RFs and users participating in the study. First, from the 28 RFs that are represented in the Faculty of Science RFs Governance Board (Acosta-Martin, 2018c), I invited to participate in the study the 23 fully economic costed (fEC) RFs that seemed to be involved in educational activities. Unfortunately, RFs from the departments of Physics and Astronomy, Mathematics and Statistics, and Psychology involved in some kind of educational activities are not represented in the Faculty of Science Facilities Governance Board. I presented the initial idea of the project to all of them in September 2018 during one of the Governance Board meetings. At a later stage, I organised an introductory meeting with those RFs showing interest in participating (13 RFs) and provided the opportunity for deeper

discussion about my motivations for doing this project, their motivations to potentially participate and any additional question that they had and could not ask before. Consent forms (**Appendices 8.5**) together with a dedicated RF information sheet (**Appendices 8.6**) were sent to these 13 RFs. At the end, 10 of them participated in the study (**Table 3.3**). The other three RFs were not able to participate for practical reasons despite their interest in the study. The 10 participant RFs represented four of the seven departments comprising the Faculty of Science: Animal and Plant Sciences, Biomedical Science, Chemistry and Molecular Biology and Biotechnology.

| Host department | Participant RFs |
|---|---|
| APS | ✓ Metabolomics - Mass Spectrometry Centre |
| BMS | ✓ Electron Microscopy Unit<br>✓ Proteomics - Mass Spectrometry Centre |
| CHM | ✓ X-Ray Crystallography<br>✓ Surface Analysis Centre<br>✓ Spectroscopy & Chromatography<br>✓ chemMS - Mass Spectrometry Centre |
| MBB | ✓ Biomolecular NMR Facility<br>✓ Electron Microscopy Unit<br>✓ X-Ray Crystallography |

**Table 3.3. List of RFs participating in research study.** Participant RFs are shown grouped by host department, which is defined by the department to which RF staff is associated to. APS: Animal and Plant Sciences, BMS: Biomedical Science, CHM: Chemistry, MBB: Molecular Biology and Biotechnology.

Second, RFs' users were invited to participate only if they fulfilled the criteria for selection shown in the data collection workflow (**Figure 3.1**), i.e. be trained to use the RF, or have used the RFs as a service and have received some sort of educational interaction at the time of receiving the results of the analysis. Users agreeing to receive the invitation-to-participate email were sent an email every time that they used a RF as information collected in the questionnaire was specific to each interaction and their perception about how important/beneficial was the interaction could evolve from one time to the following one.

Due to the relatively manageable size of RFs in the Faculty of Science, using a purposive sampling offered the possibility of increasing sample accuracy (Oppenheim, 2000), and potentially increasing finding's accuracy. User's sample, as it was derived from RFs' data, also benefited from this effect.

## 3.7. ETHICAL CONSIDERATIONS

Regarding ethical considerations, this project had the advantage of not involving vulnerable participants or highly sensitive topics and it did not represent any risk for either participants or myself. RFs participating in the study were given a random identification code (from RF01 until RF10) in order to protect their identity and avoid situations or feelings of judgement, competition or comparison. Each RF only knew their own code and I, as researcher, was the only person knowing the correspondence between RFs and codes.

RFs' users had to give their verbal or written consent before they were sent the link to the questionnaire. Users' responses to the questionnaire were collected anonymously so that their identities were not traceable. By protecting the identity of RFs' staff and making the surveys available to users in a voluntary and anonymous way, the level of mental stress due to participating in the study was greatly reduced, if any. This study was approved by the School of Education Ethics Review Panel (**Appendices 8.7**).

## 3.8. VALIDITY

The validity of a research tool, test or method refers to the degree to which it actually measures what it is supposed to measure (Wellington, 2015). Wellington also said in his book that we can never be 100 per cent sure of validity. Taking into account the definition of *contribution* "The part played by a person or thing in bringing about a result or helping something to advance.", there are two obvious elements to be considered: "the part played", the role and the deployment required to exercise it, and the "bringing about a result", as the consequences. Having this in mind, I decomposed the contribution of RFs to education into two parts: 1) contribution in terms of input (resources), what resources were used that make that contribution possible? and 2) contribution in terms of output (impact, benefits), what was the result of using those resources?. These two parts gave rise to two more specific research questions, and I designed two research tools, the logbook and the user questionnaire, each one used to have a look at one of those parts. Decomposing the contribution of RFs to education into more precise aspects according to the definition of contribution greatly helped to identify the kind of research methods that I wanted to use in order to gatherer relevant information. The fact that I aimed at collecting data from several RFs and users, together with the limited amount of time to develop the study, had an important influence in shaping these tools with a rather quantitative character. If the study was aiming at providing a deeper understanding of this "contribution", a more qualitative approach might have been more useful to gather more detailed information about the how-to of using those resources and importantly, about the how-to of the

impact. A final element that made me consider these research methods as valid enough to address the research questions of the study was the lack of the literature about the subject compared to my own experience as RF manager. I first needed to understand whether the educational work that I thought I was doing was the norm or an exception and I could only understand that by looking at the work that other RFs were doing to build a larger picture that would allow me, in a later stage, have a look at the details of that work.

## 3.9. RELIABILITY

The reliability of a research tool, test or method refers to the extent to which it gives consistent results across a range of settings and if used by a range of researchers (Wellington, 2015). Therefore, the structured and quantitative character of the logbook and the user's questionnaire provided a high degree of reliability. This was somehow proven by the successful application of these tools by multitude and diversity of RFs participating in the study.

In this research, participant RF were all from the Faculty of Science, which makes me wonder whether these methods would be applicable for RFs in the social sciences. They would certainly need some adaptation regarding questions about the resources and the types of interaction with users. In the natural sciences, RFs are driven by state-of-the-art technology and instrumentation plays a centric role in the way of functioning of RFs. In the social sciences, where these large and expensive pieces of equipment are not required, RFs might consist on the use of adapted rooms or other creative or analytical tools. A clear example could be a statistics facility to which users would go to get support in the analysis of their data. Another example can be found in the subject of psychology, sometimes classed together with the natural sciences and sometimes with the social sciences, using RFs and technology like virtual reality laboratories or music cognition facilities to investigate human behaviour (Radboud University, n.d.). In summary, the questionnaire and the logbook were reliable tools that could be applicable for the study of RFs in the natural sciences, but that would be not directly applicable and require content modification to be suitable to other fields such as in social sciences.

## 3.10. CREDIBILITY

Credibility is defined as the confidence that can be placed in the truth of the research findings (Holloway and Wheeler, 2002; Macnee and McCabe, 2008 cited by Anney, 2014) and establishes whether or not the research findings represent plausible information drawn from the participants' original data and is a correct interpretation of the participants' original views (Graneheim and Lundman, 2004; Lincoln and Guba, 1985 cited by Anney, 2014). Due to the anonymity of RF users'

responses, I could only return to RFs' staff to check whether the interpretation of the data represented their view. I expected that the design of the logbook used to record data from RFs (mostly quantitative information with little qualitative data) facilitated this verification step. After analysing the data and drawing preliminary conclusions, I organised a meeting with RFs' staff in order to share the results and the interpretation that I was doing. At this stage, they provided additional valuable insights to already existing conclusions, which appeared to be authentic and representative of their view (Cutcliffe and McKenna, 1999).

## 3.11. TIMELINE

Data collection was carried out for six consecutive weeks and started on 18th March 2019. RFs had to fill in the logbook on a weekly basis (every Friday), so I could use the list of users' email addresses on the following Monday and send them the invitation-to-participate email. Data collection for RFs finished on Friday 29th April, 2019 and due to unexpected personal circumstances I could only close the user's questionnaire on 14th May, 2019 (eight days later than planned: 6th May, 2019) but this did not have a relevant impact on the data as only one response was received during this delayed period.
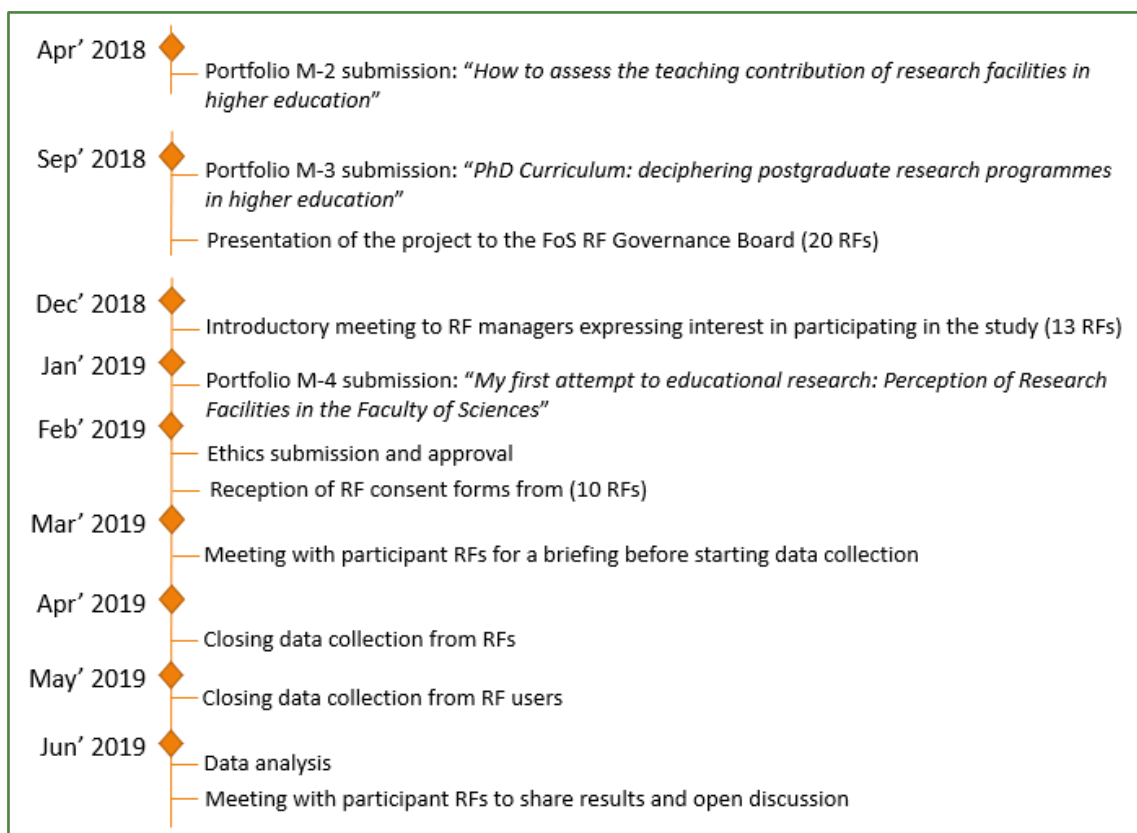


**Figure 3.2. Timeline for the development of the present study.** Schematic timeline showing main steps of the project.

It is worth mentioning that these six weeks included a variety of working days: regular working days, bank holydays, and Spring semester Easter vacation days, which could influence the amount and nature of collected data. A more general overview of the timeline used for this piece of research is shown in **Figure 3.2**, including early steps of writing portfolios for the second (M-2) and third (M-3) modules of the MEd, which were an important part of the initial reflexion process.

## 3.12. DATA ANALYSIS PROCESS

### 3.12.1. LOGBOOK: RF'S DATA

An additional column "Week" was added to all data spreadsheets in each logbook, and values from Week-1 to Week-6 were manually entered for all registered activities according to their chronology, so that data could be then analysed and grouped *per* week. Then, Google Spread Sheets files were downloaded as excel files and all entries registered by participant RFs during the six weeks of data collection were pooled together in a separate spreadsheet. This combined spreadsheet was used as a starting point for further data analysis.

#### 3.12.1.1. VALIDATION FOR INCONSISTENCIES

The information in each entry of the combined spreadsheet was carefully read in order to check whether there were inconsistencies in the data. For example, if the field *Brief description of the activity* was "training user in the use of the instrument", I checked that *How many major pieces of equipment were involved in the activity?* had a value different than zero. Entries with inconsistencies were sent back to RF staff in charge of data collection for clarification. After clarification, inconsistent entries were modified in the combined spreadsheet, so they could be part of the final pool of data.

Another aspect that was validated was the fact that all entries fulfilled the criteria for collection according to the data collection workflow (**Figure 3.1**). For example, there were entries in which *How many facility staff were involved in the activity?* was zero. After asking RF staff about these entries, the conclusion was that they corresponded to cases in which the user independently used the facility without having any type of interaction with RF staff. Therefore, these entries did not fulfil the criteria for inclusion in the logbook, which required to have a training/teaching interaction with the user.

RF staff was very collaborative in clarifying all inconsistent or unclear data. Their responsiveness was a key element in maximising the used of collected data and in successfully carrying

out the research within a restricted timeline. All entries that, after clarification, did not follow the data collection workflow were excluded from the dataset (**Figure 3.3**).
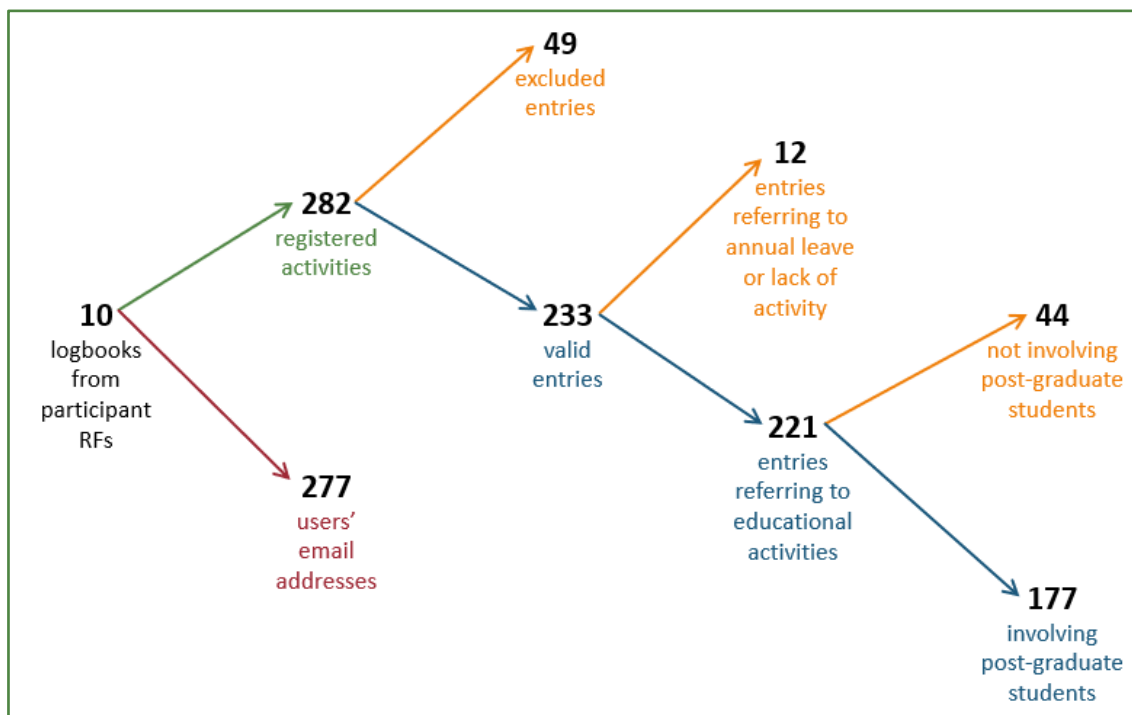


**Figure 3.3. Schematic representation of the data generated in participant RFs.** Number of entries after validation and classification of registered activities are shown.

### 3.12.1.2. STATISTICAL ANALYSIS

In order to perform statistical analyses, qualitative information contained in column *Brief description of the activity* was manually classified into the following categories: Theory, Experimental design, Sample preparation, Instrument use, and Data analysis and interpretation. These categories were derived from the original content of the entries, so that each entry could logically fall into one or more of them. Afterwards, with the aid of Excel, data in all columns containing descriptive information was coded with numerical values and a legend was generated so I could easily interpret the information without the need of inspecting the original data file. The new coded file was saved as a comma separated values file and analysed with an evaluation copy of the software StatXact (Version 11.1.0). Frequency distributions were used to describe the variety of registered educational activities developed in RFs. These statistical results were copied into an Excel sheet for graphical representation. Finally, I focused the analysis on only those activities that involved users that were PG students. Thus, I could understand how much of described resources were used for the education of PG students. For this subset of data, statistics and representation was similar to the one performed on the whole dataset.

### 3.12.2. USER'S QUESTIONNAIRE

The responses from the Google Forms questionnaire were automatically organised in a Google Spread Sheets table. This table was downloaded as Excel file and used as starting point for quantitative data analysis. In order to perform statistical analyses, text responses (department, status, institution, type of interaction and how important/beneficial was the interaction with the RF) were replaced by numerical values. This coded file was treated with an evaluation copy of the software StatXact (Version 11.1.0). Frequency distributions were used to describe the population of respondents and their perceptions. These statistical results were copied into an Excel file for graphical representation. Then, I focused on the responses from PG students, and did a similar analysis to the one performed on the whole population of respondents.

In summary, taking into account my own perspective as RF manager, the methodology that I applied for this research consisted of a mixture between post-positivism and interpretivism. I developed a collaborative work with participant RFs and used logbooks to gather data about the types of educational activities carried out in those RFs and the resources that they used in such activities. RF users participating in educational activities received a questionnaire which data were used to evaluate the impact of educational activities. After six weeks of data collection, data was combined, coded, statistically analysed and represented for an easier interpretation.

# * 4. FINDINGS *

Data collected from participant RFs gave rise to two streams of information about educational activities, one generated in RFs and the other one generated by RF users. The findings from the analysis of both datasets were grouped in sections addressing: the profile of RFs and users participating in the study; characteristics of educational activities carried out in RFs, including their content, required resources, and distribution over time; and the impact of those activities for all participant users and for PG students specifically. This classification allowed a better understanding and interpretation of findings.

## *4.1. PROFILE OF RFs PARTICIPATING IN THE STUDY*

Participant RFs were 10 fEC RFs (**Table 3.3**) from the Faculty of Science that represented four of the seven departments comprising the Faculty of Science. Neither the number of RFs nor their proportion was equivalent across the four represented departments (**Figure 4.1**). Chemistry was the department having the highest number of RFs participating in the study (4 RFs), but the highest representation was for Molecular Biology and Biotechnology (75%). Animal and Plant Sciences had the lowest number of RFs participating in the study (1 RF) and Biomedical Science was the one with the lowest representation (29%).
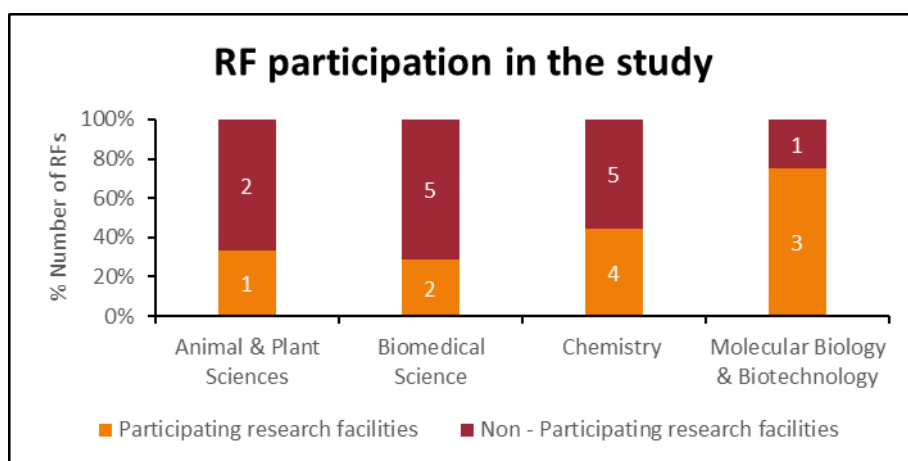


**Figure 4.1. Participation of RFs across departments.** Absolute numbers are shown for each category, while the percentage representation is indicated through the vertical axis.

After manual validation of logbooks' data, there were 233 valid entries, from which 12 made reference to lack of activity or annual leave and the remaining 221 made reference to educational activities. Considering those 221 valid educational activities, the distribution of registered activities across RFs was highly variable (**Figure 4.2**). Four RFs registered 10 or less activities, two registered

around 20 activities, and four registered more than 30 activities during the six weeks of data collection. Between the RF with the lowest and the one with the highest number of educational activities there was almost a 10-fold difference (five for RF04 and 48 for RF03). While it is difficult to extrapolate this proportions to remaining RFs in the Faculty of Science that did not participate, this diversity of numbers clearly represents the heterogeneity of *modus operandi* of how RFs carried out their work.
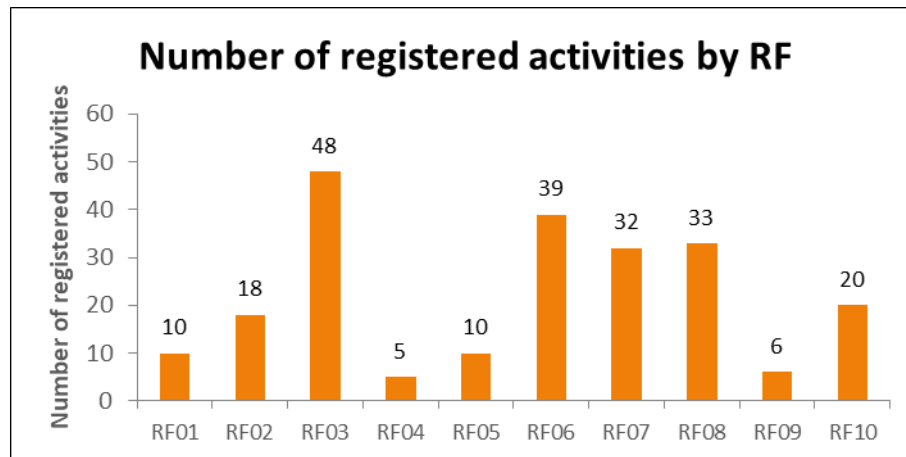


**Figure 4.2. Educational activities across RFs.** Absolute numbers are shown for each category. Each activity accounts for one entry in the logbook. RFs are represented by their unique identity code (from RF01 to RF10) that was randomly assigned for anonymisation purposes.

## 4.2. EDUCATIONAL ACTIVITIES IN RFs OVER TIME

Data collection was carried out in RFs (resources data) during six weeks (**Table 4.2**), from Monday 18th March until Friday 26th April, 2019, while data collection from users (impact data) was shifted by one week as I have to wait until the end of each week to have the complete list of user's email addresses from RFs' data in order to send the invitation-to-participate email.

| MONDAY | TUESDAY | WEDNESDAY | THURSDAY | FRIDAY |
|---|---|---|---|---|
| | | Week-1 – Starting 18th March | | |
| | | Week-2 – Starting 25th March | | |
| | | Week-3 – Starting 1st April | | |
| | | Week-4 – Starting 8th April | | |
| | | Week-5 – Starting 15th April | | |
| | | Week-6 – Starting 22nd April | | |

**Table 4.2. Weekly time frame for data collection in RFs.** Types of working days are represented by colours: regular working days (green), Spring semester Easter vacation (blue), and bank holidays (red).

The six weeks of data collection fell around the Spring semester Easter vacation and included two bank holidays in which the University was completely closed. Although the Spring semester Easter Vacation is mostly affecting attendance of undergraduate student, the fact that two bank holidays were included in this period could have facilitated University staff and PG students also taking annual leave. Additionally, school holidays in Sheffield coincided with Week-3 and Week-4 of data collection, and it is quite common that parents take annual leave during school holidays, particularly if they have young children. In general, many staff and PG students with young children would also follow this pattern of behaviour. When having a look at the number of RFs reporting data every week (**Figure 4.3**), the 10 RFs collected data during the first and the last week only. In each of the other four weeks, only eight facilities were collecting data. On top of this, RFs reported absence of educational activities in four occasions. Therefore, this temporary context, including the semester vacation, bank holidays, and school holidays, could have had a certain degree of influence in the amount of data collected, but only a study including a larger period of data collection will allow a confident relationship between these two facts.
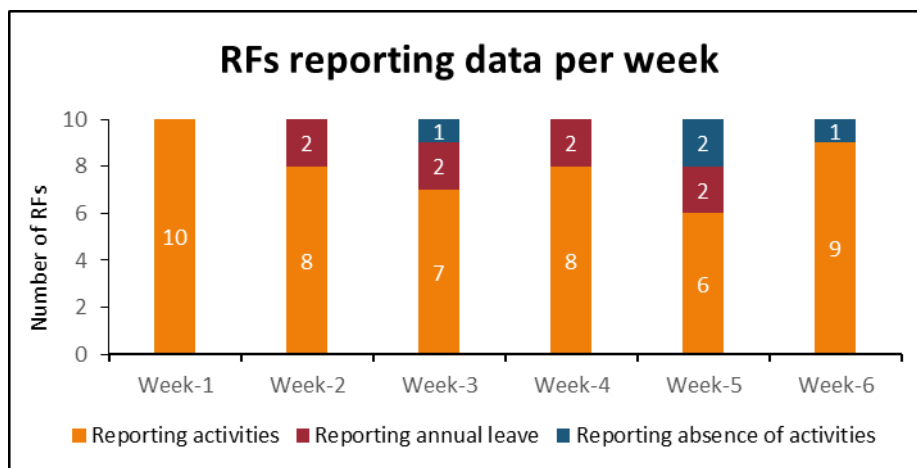


**Figure 4.3. Overview of the number of RFs reporting data over time.** Each activity accounts for one entry in the logbook.

Regarding the number of registered activities per week, the 221 activities were distributed in time as shown in **Figure 4.4**, generally, the more RFs reporting activities, the higher the number of registered activities per week.
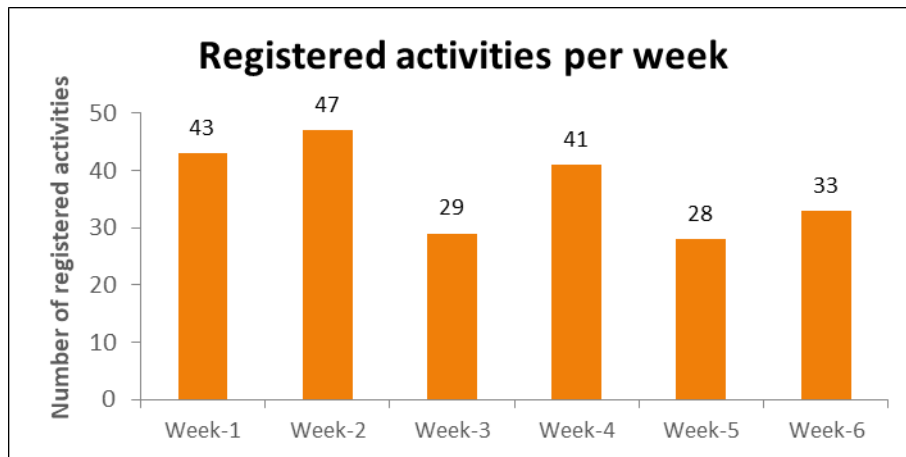
**Figure 4.4. Number of registered educational activities over time.** The number of activities reported by all RFs is represented. Each activity accounts for one entry in the logbook.

The number of users that were involved in registered activities (**Figure 4.5**) was slightly higher than the number of educational activities registered per week, suggesting that some of the activities involved several users. In total, 264 users were involved in the 221 registered educational activities. In addition of registering the number of users involved in educational activities, RFs' staff was in charge of asking all trained users for permission to be sent an invitation-to-participate email with a link to a questionnaire. Email addresses of users giving permission were registered in a separate table of the logbooks.
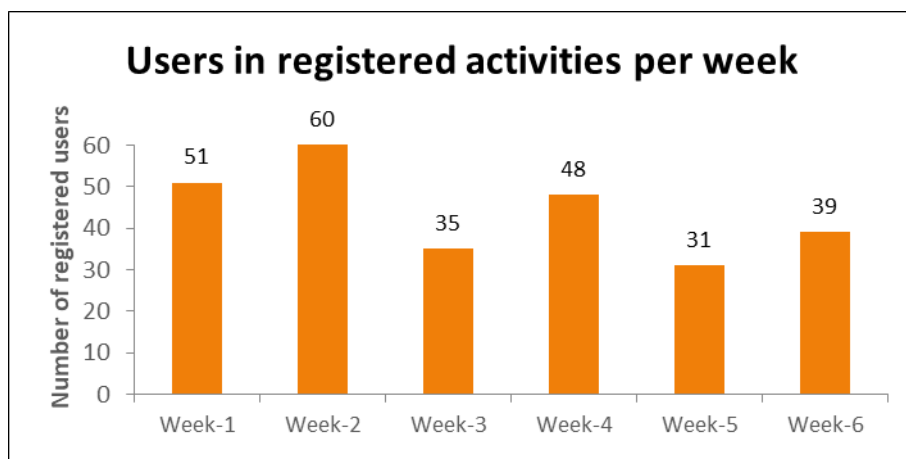


**Figure 4.5. Temporal distribution of the 264 users involved in registered educational activities.** The number of users reported by all RFs is represented.

The number of registered user email addresses (**Figure 4.6**) was slightly different in absolute total numbers (44, 64, 34, 53, 36, and 46, respectively for weeks 1 to 6) to the number of users in registered activities (**Figure 4.5**). A higher number of user email addresses meant that additional independent trained users accessed RFs during that week, while a lower number indicated that not all

users accessing RFs in that week were interested in receiving the invitation-to-participate email. By having a look at the list of email addresses I distinguished two types of users: the ones accessing any of the participant RFs for the first time during the data collection period, and the ones that already used any of the RFs in previous weeks of data collection (**Figure 4.6**). After the six weeks, there were 145 unique email addresses collected in all combined logbooks, which were used to send 277 invitation-to participate emails.
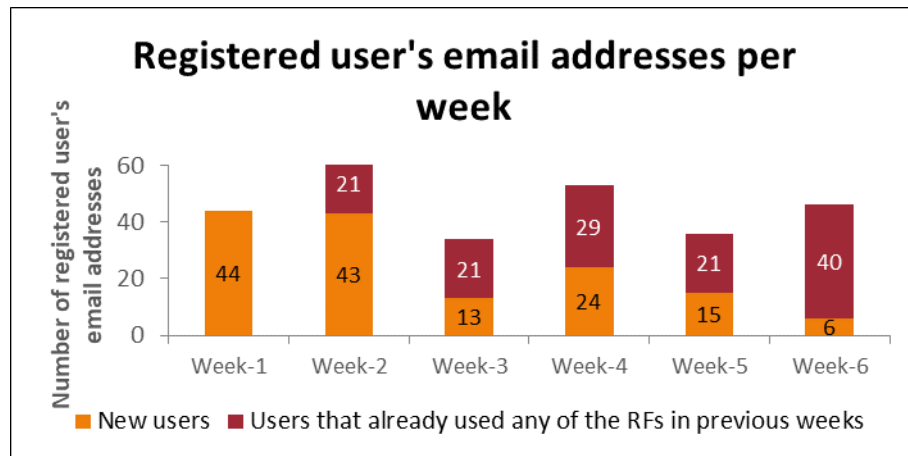


**Figure 4.6. Number of users reported in RFs' logbooks over time.** The number of user's email addresses reported by all RFs is represented.

In the invitation-to-participate email, users were asked to fill in the survey within a week, so I could make a rough temporal association between the two datasets. The number of questionnaire responses (**Figure 4.7**) correlated with the number of emails sent per week, suggesting that most users did actually respond to the survey within a week.
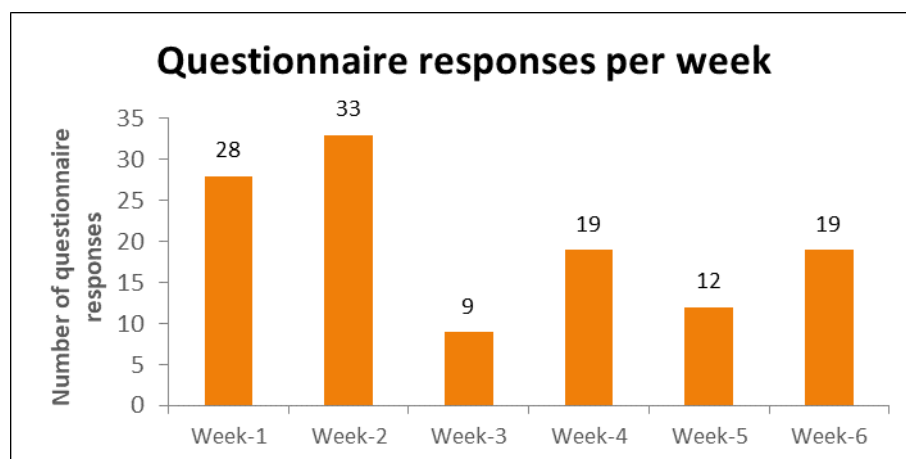


**Figure 4.7. Temporal distribution of the 120 questionnaire responses.**

By the end of the study, 120 responses were received. Considering the total number of emails sent (277), the overall response rate corresponded to 43%. Because I used triangulation methods to

validate data collected in logbooks and through the questionnaire, I could validate that responses in the questionnaire were representative of the population of users accessing RFs, indicating no evidence for nonresponse bias (Reio, 2007; Oppenheim, 2000).

In summary, external social factors like national bank holidays or school holidays can affect the amount of educational activities carried out over time, possibly due to RF staff and users on annual leave.

## 4.3. PROFILE OF USERS RECEIVING EDUCATION IN RFs

It is important to remember at this stage that whereas resources' data included only users having an educational interaction with RF staff, impact data also included users who were trained previously to the data collection period and were using RFs independently without the need of interacting with RF staff, providing a wider picture in terms of the research project time window. However, none of the datasets considered users that used the RFs as a service, as the aim of this project was not to have a complete detailed picture of all the work carried out in a RF, but only focus in the educational part.

### 4.3.1. RECURRENT USERS OF RFs

Having a look at in how many weeks the same user's email address was collected, I had an indication of how recurrent the use of RFs was. During the six weeks of data collection, 53% of the 145 users accepting to receive the invitation-to-participate email were recurrent users of participant RFs (**Figure 4.8**). These figures only considered users that were reported to use the same RF in following weeks (their email address was reported by the same RF). This repetitive use of RFs over the weeks could have different interpretations. First, experiments performed in RFs take more than one week, second, experiments take less than a week but need to be repeated in order to improve or confirm results, third, recurrent uses of RFs correspond to different non-related experiments. Any of these situations was possible in the framework of this research, and the amount of reiterative uses of the same RF by the same user was significant.

An additional piece of information that I could extract from the list of user's email addresses was the number of users using different RFs in same week. From the 145 users agreeing to receive the invitation-to-participate email, 139 (96%) used only one RF per week, five users used two RFs in the same week and one user used three RFs in the same week. This could be interpreted as most users would require concentrating in the use of one RF at a time and could only possibly use more than one RF if the time needed for each one was short enough so they could be combined within a week.
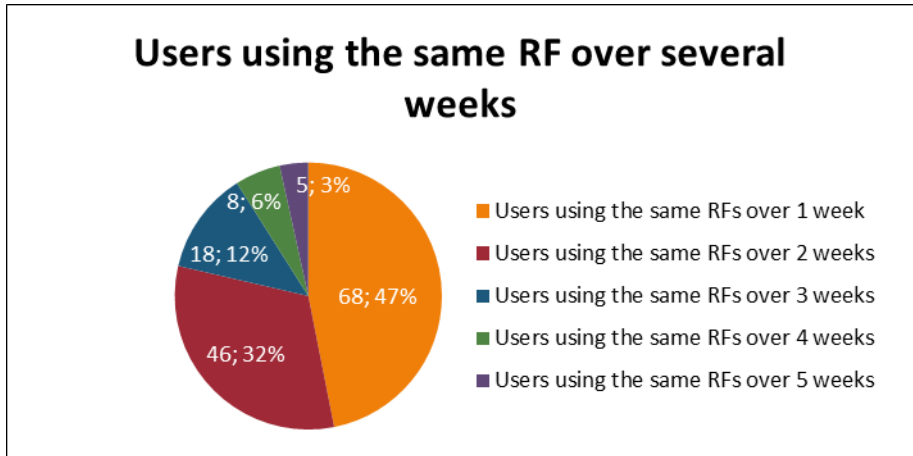
**Figure 4.8. Number of users whose email address was collected over multiple weeks in RF's logbooks.** Absolute and percentage numbers are shown for each category. Each of the 145 users agreeing to receive the invitation-to-participate email is represented only once. If any of the users used more than one RF in different occasions, only the highest frequency was considered for representation.

### 4.3.2. RF USERS' INSTITUTION

The institution of RFs' users was collected through the two datasets, registered activities in logbooks (**Figure 4.9**) and questionnaire responses (**Figure 4.10**). The distribution in both datasets followed the same tendency and showed that RF users from the University of Sheffield represented between 97% and 99% of total users.

In the following sections dedicated to the profile of users receiving education in RFs (sections 4.3.3, 4.3.4 and 4.3.5), I focus on that major group of users who were from the University of Sheffield.
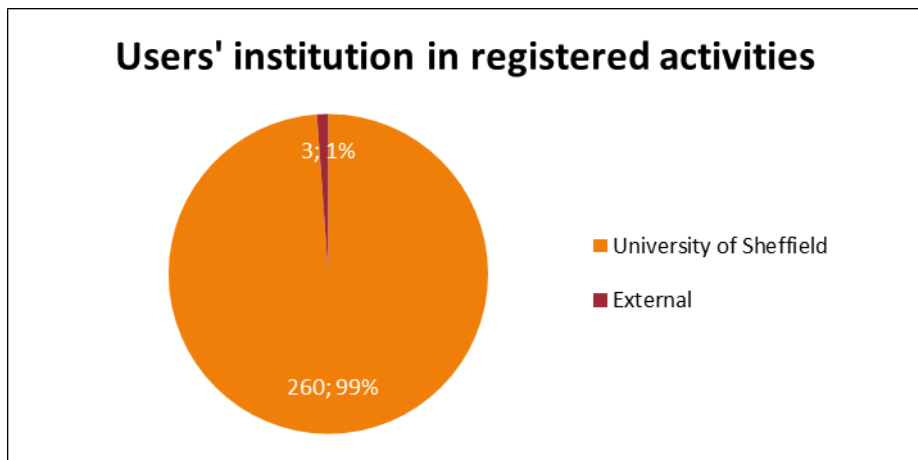


**Figure 4.9. Institution of the 264 RFs' users involved in registered activities.** Absolute and percentage numbers are shown for each category.
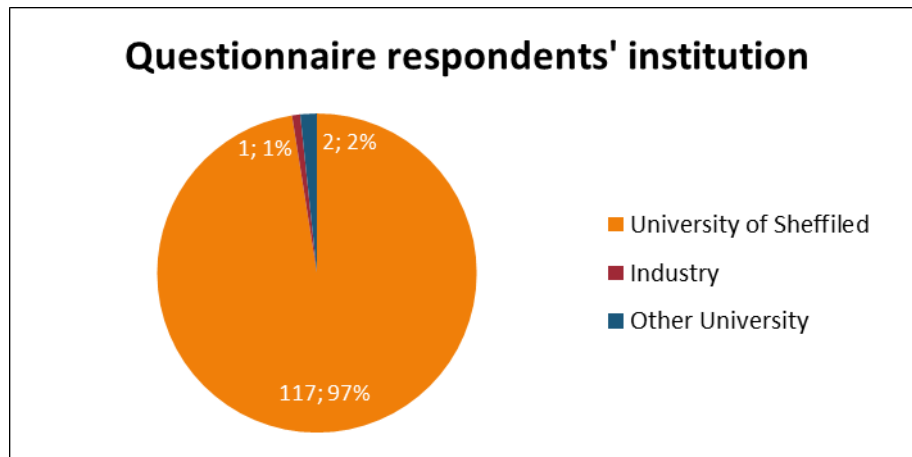
**Figure 4.10. Institution information collected in the 120 questionnaire responses.** Absolute and percentage numbers are shown for each category.

### 4.3.3. UNIVERSITY OF SHEFFIELD USERS' FACULTY & DEPARTMENT

At the University of Sheffield there are five faculties located in the Sheffield campus and the International Faculty which main campus is in Thessaloniki, Greece. RFs' users from the University of Sheffield responding to the questionnaire represented four of the five Sheffield faculties (**Figure 4.11**). Almost 80% of these users were from the Faculty of Science, host of the RFs participating in the study. The other 20% was shared between the Faculty of Engineering, the Faculty of Medicine, Dentistry and Health. The Faculty of Arts and Humanities was represented by one user.
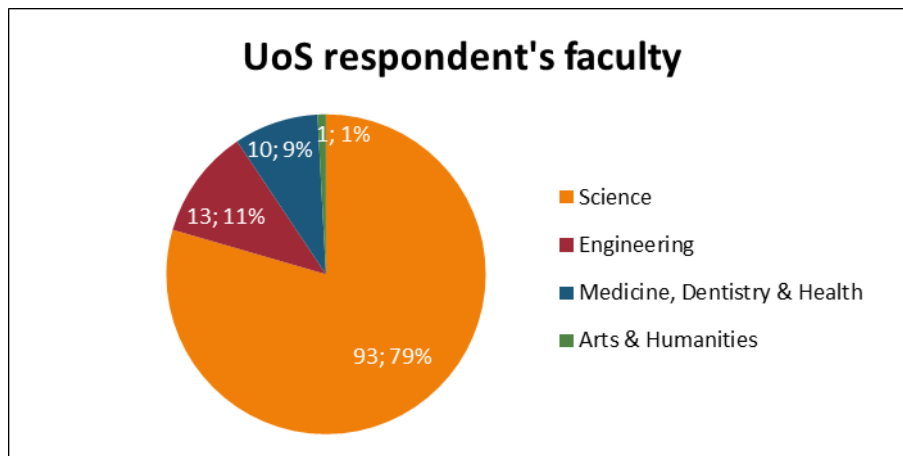


**Figure 4.11. Faculty representation for questionnaire responses from the University of Sheffield (UoS).** Absolute and percentage numbers are shown for each category.

When having a detailed look into which departments were represented for each faculty (**Figure 4.12**), 10 departments were represented across the four faculties. Two of those had a significantly higher representation amongst users responding to the questionnaire: Chemistry, and Molecular Biology and Biotechnology, accounting for 70% of the total representation. The department

of Chemistry on its own represented almost 50% of respondents. This departmental diversity across faculties highlights the diversity of users and research projects integrating the work developed in RFs.



**Figure 4.12. Departmental representation for questionnaire responses from the University of Sheffield (UoS).** Absolute and percentage numbers are shown for each category.

### 4.3.4. FACULTY OF SCIENCE USERS' DEPARTMENT

Because participant RFs were from the Faculty of Science (**Figure 4.13**), I decided to have a more detailed look at users from departments in the same faculty (**Figure 4.14**) and tried to identify any connections between the two pieces of information.
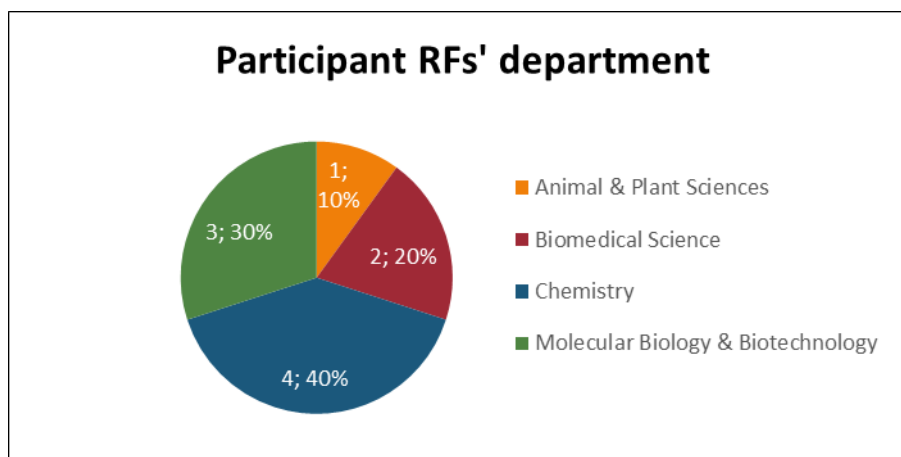


**Figure 4.13. Faculty of Science departments' representation for participant RFs.** Absolute and percentage numbers are shown for each category.
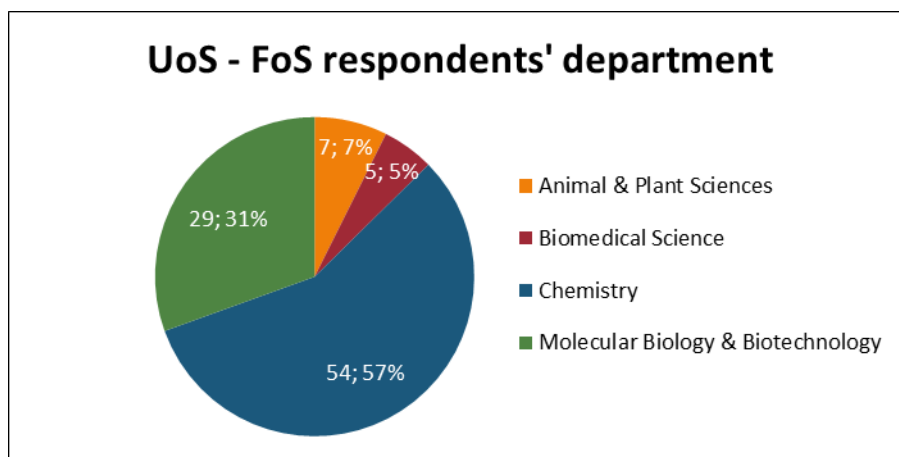
**Figure 4.14. Faculty of Science (FoS) departments' representation for questionnaire responses from the University of Sheffield (UoS).** Absolute and percentage numbers are shown for each category.

First, the same four departments were also the only ones represented by users responding to the questionnaire. Therefore, none of them belonged to the departments of Physics and Astronomy, Mathematics and Statistics, or Psychology. Given the diversity of users accessing RFs during the data collection period, it seems difficult to identify the reasons for this lack of representation. This also opens a door to motivate more interactions between represented and non-represented departments in the Faculty of Science. Additionally, the two major groups of RF users within the Faculty of Science were from Chemistry, and Molecular Biology and Biotechnology, which also were the two departments with the highest numbers of participant RFs. This fact could suggest that major groups of RF users come from the same host department of used RFs. However, because the questionnaire did not make any questions about what specific RF was used by the respondent, there is no direct evidence to support this statement.

### 4.3.5. UNIVERSITY OF SHEFFIELD USERS' STATUS

Together with RFs' user institution, the status of RFs' users was the only other variable about user's profile that was collected through the two datasets. The status of users from the University of Sheffield in registered activities (**Figure 4.15**) and questionnaire responses (**Figure 4.16**) followed the same distribution and showed that a significant major group of RF users, accounting for around 65% of all users from the University of Sheffield, were PhD students. The least represented groups in both datasets were academics and technicians. This lower representation could be explained by the fact that many academics use RFs through members of their research groups and are not directly involved in performing the experiments. Technicians usually developed their work in their assigned laboratories, having fewer opportunities for interaction with RFs.

Regarding data from the questionnaire, the two responses from *Other Universities* were also PhD students. Although, it is increasingly common to find research collaborations between academia and industry involving PhD projects, the response from *Industry* was from a professional worker and not from a PhD student.
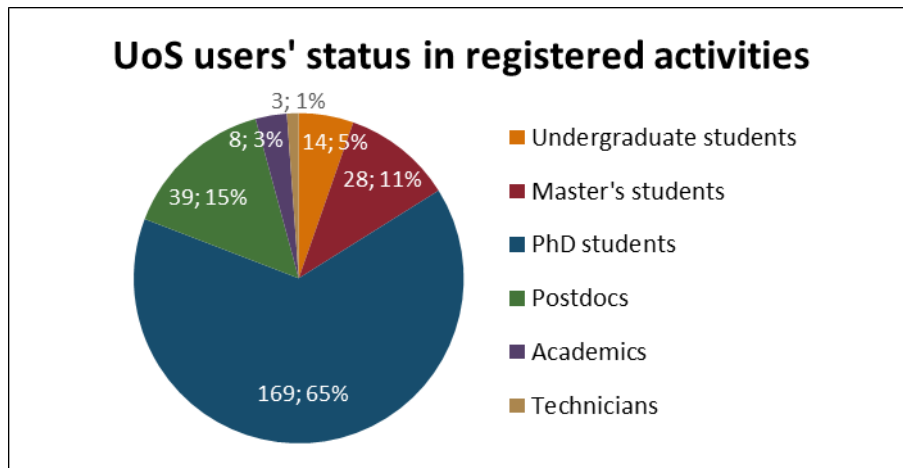


**Figure 4.15. Status representation for users from University of Sheffield (UoS) registered in educational activities.** Absolute and percentage numbers are shown for each category.
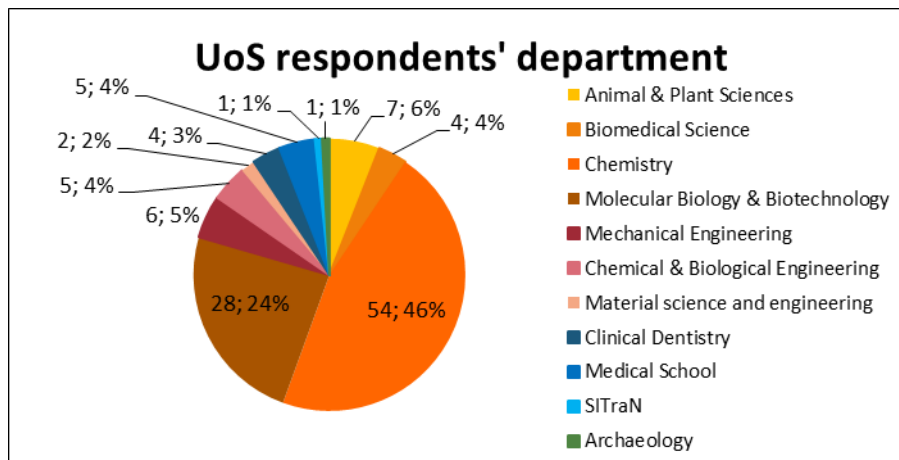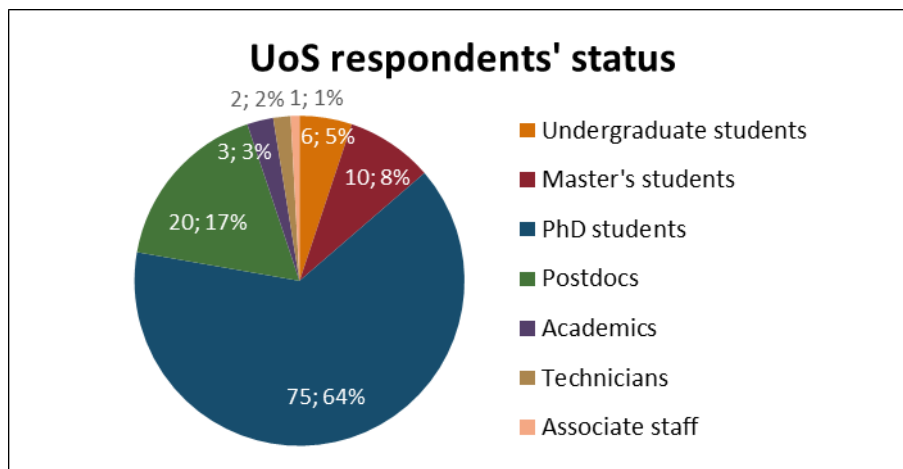


**Figure 4.16. Status representation for questionnaire responses from the University of Sheffield (UoS).** Absolute and percentage numbers are shown for each category.

Therefore, summarising the profile of users receiving education in RFs, the findings revealed that between 97% and 99% were from the University of Sheffield. From these, almost 80% of users were from the Faculty of Science, host of participant RFs, and around 75% were PG students. In addition, it appeared that around 50% of users were recurrent users of the same RF.

## 4.4. DESCRIPTION OF EDUCATIONAL ACTIVITIES CARRIED OUT IN RFs

In total, during the six weeks of data collection there were 221 activities registered in RFs' logbooks. All of them were classed as non-formal activities. In the context of this study, the distinction between formal and non-formal educational activities was made in relation to the formal acknowledgment for its development. For instance, some RFs carry out Doctoral Development Programme courses and if they had been carried out during the data collection period, they would have been classed as formal because they have an associated module code, and a number of credits are given to students attending these courses. This information would go into the official training records of the student. However, when students, or any other kind of users, go to RFs and receive training as part of carrying out their research experiments, as was the case of the 221 registered educational activities, this training does not go into any official records and the fact that it occurred is not recognised or acknowledge in any official or formal way.

Having a look at the type of interaction between RF staff and users involved in registered activities (**Figure 4.17**), 90% of them were one to one interactions, which is translated in an extremely high ratio of "human resources" compared to classical lecture type education in which one member of staff is interacting with a few dozens, or even, hundreds of students at the same time. In 19 occasions, more than one user was involved in the same registered activity, and three registered activities referred to a progress update meeting in which three members of staff advised one PhD student.
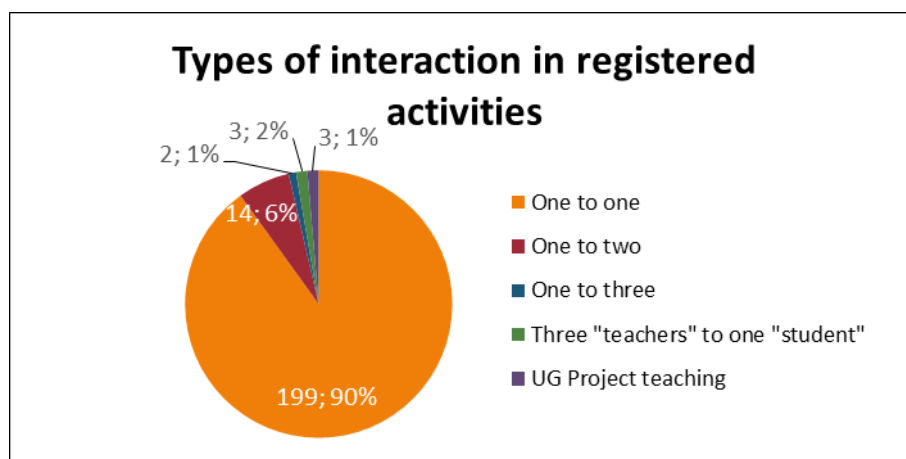


**Figure 4.17. Types of interactions defining the 221 registered activities.** Absolute and percentage numbers are shown for each category.

The content of educational activities was collected through the two datasets, registered activities in logbooks (**Figure 4.18**) and questionnaire responses (**Figure 4.19**). In both cases, a single entry, i.e. either a registered activity or a questionnaire response, could make reference to more than one type of content. The activity content with highest frequency for both datasets was training RFs' users in the use of instrumentation (blue bars). This makes sense in relation to the intrinsic nature of RFs that are indeed driven by the use of state-of-the-art equipment. Training in sample preparation (red bar) was not included amongst the choice of answers in the questionnaire due to an inadvertent negligence when preparing the data collection tools, so respondents were not able to select it, being the only type of activity content that was not represented in both datasets. It might be that some of the respondents receiving training in sample preparation selected *None of the above* (light brown bar), but the lack of more detailed information did not allow to make a direct connection between these two categories. The option *None of the above* was designed for those users that were trained in the past and used the RF independently (without interacting with RF staff) during the data collection period. In general, RFs' users reported a higher percentage of all types of activity contents compared to the data reported by RF staff. The most obvious disagreement between the two datasets was related to theory (purple bars). While RFs reported teaching theory in only three of the 221 registered activities, there were 57 of the 120 questionnaire responses reporting being taught theory, evidencing a strong divergence of perceptions about what is happening during the interaction between the two parties: RF's staff and users.
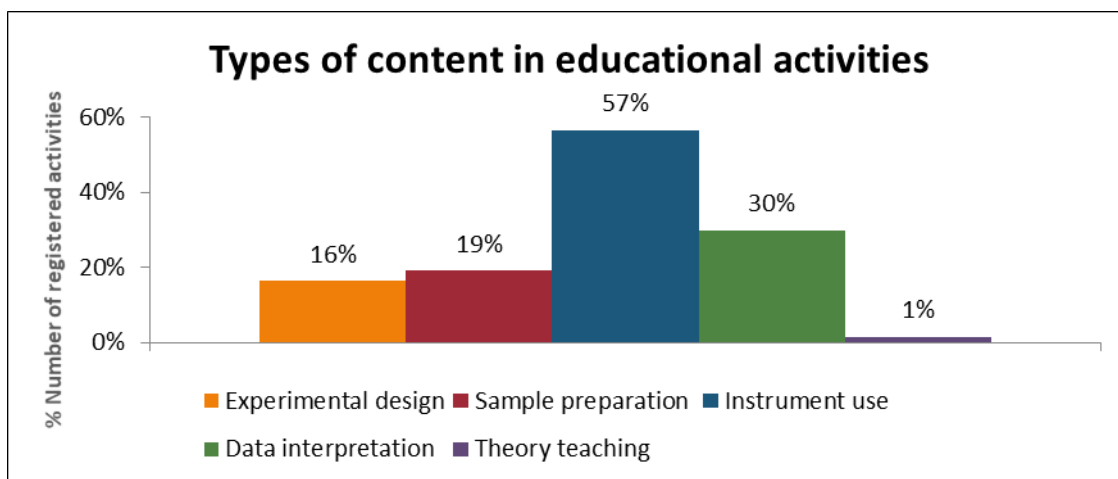


**Figure 4.18. Types of content in educational activities registered in RF's logbooks.** Percentage numbers are shown for each category. By order of appearance, 36, 42, 125, 66, and 3 educational activities reported each type of activity.
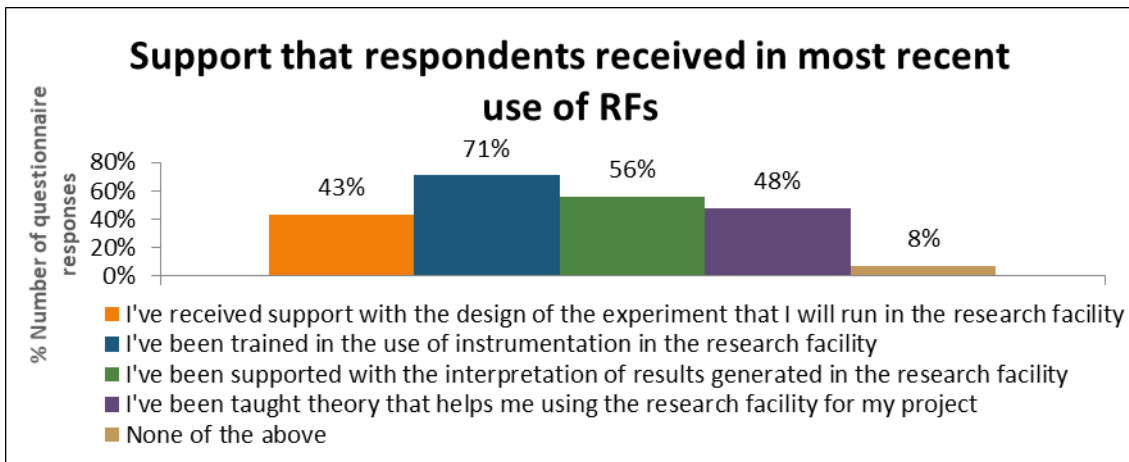
**Figure 4.19. Types of support given in RFs to questionnaire respondents.** Percentage numbers are shown for each category. By order of appearance, 52, 85, 67, 57, and 9 questionnaire responses reported each type of support.

Finally, the distribution of the content in educational activities over time (**Figure 4.20** and **Figure 4.21**) did not follow any obvious pattern of continuity. Logically, activities should be carried out in the following order: first, discussion about the design of the experiment; then, sample preparation according to experimental design; next, use of the instrument to analyse prepared samples; and finally, interpretation of acquired data. The teaching of theory could be introduced together or between any of those steps. This lack of continuity suggests that users at all stages of the process are always using RFs. The temporal profile of academic research shows here its continuous pace as opposed to teaching programmes heavily marked by the beginning and end of the academic year.
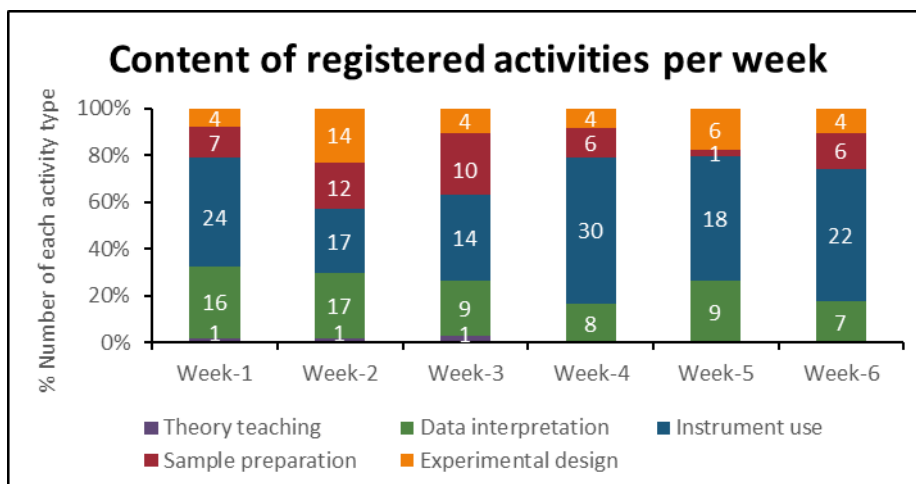


**Figure 4.20. Types of content in educational activities registered by the 10 RFs over time.** Absolute numbers are shown for each category, while the percentage representation is indicated through the vertical axis.
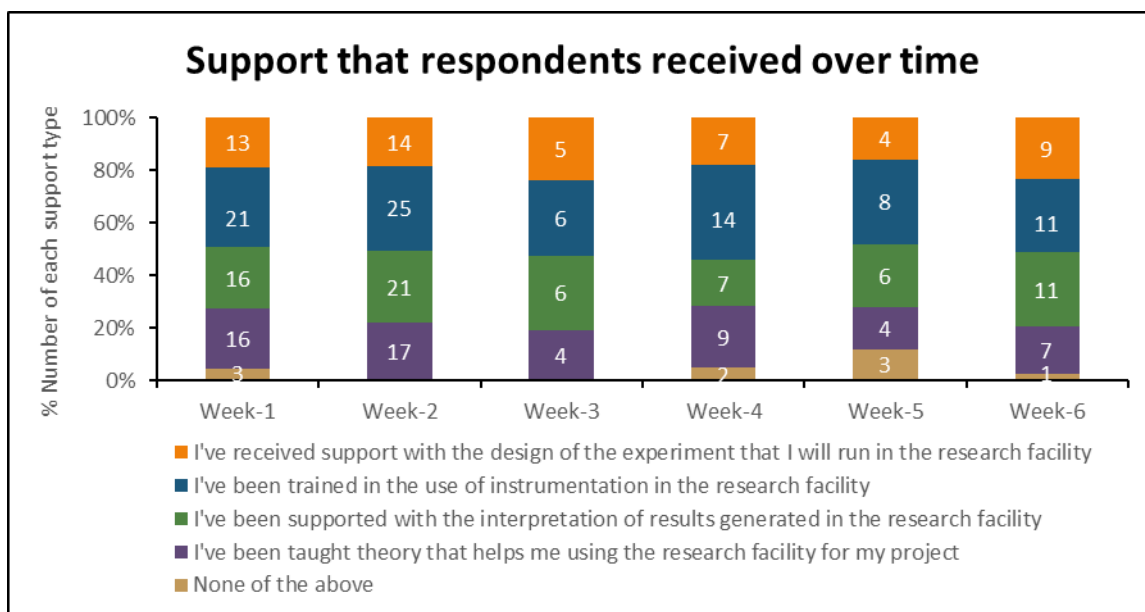
**Figure 4.21. Types of support that the 120 questionnaire respondents received over time.** Absolute numbers are shown for each category, while the percentage representation is indicated through the vertical axis.

In summary, all reported activities were non-formal and 90% were one to one interactions. Regarding the type of content, most activities included the use of instrumentation. However, users perceived that the support that they received was more diverse in content compared to the perception of RF staff.

## 4.5. RESOURCES USED FOR EDUCATIONAL ACTIVITIES IN RFs

For each registered activity in the RF's logbook data, the amount of time, staff and equipment involved in the activity was recorded in order to assess the different kinds of major resources used in educational activities in RFs. Regarding the amount of time spent in registered activities (**Figure 4.22**), 166 (75%) of them lasted within the hour. The longer time that any of the registered activities lasted was 14 hours (two working days), corresponded to the training of undergraduate and Master's students, and was described as "*Teaching practical data collection routine and theory procedure for solving results and interpretation of data*".

Almost half (48%) of the registered activities (107 out of the 221) required preparation before users went to RFs. The time spent in preparing the forthcoming educational activity was in 78% (84 out of 107) of the cases less than 30 minutes (**Figure 4.23**).
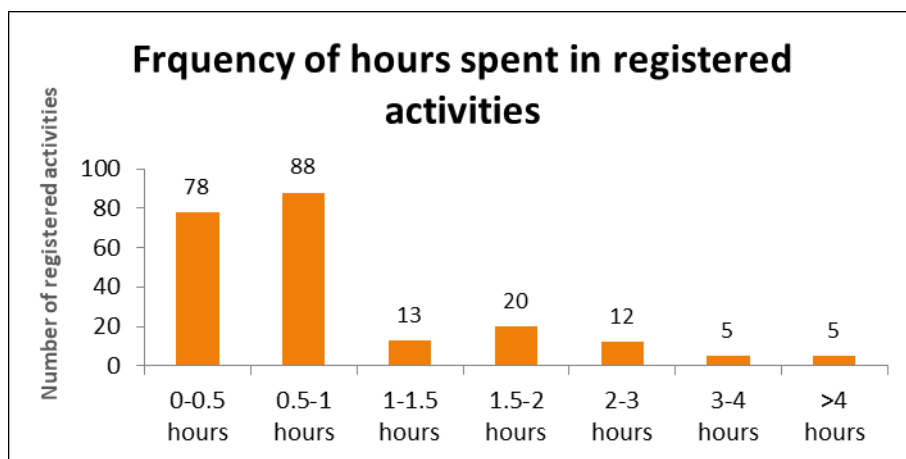
**Figure 4.22. Time invested in carrying out registered educational activities.** Absolute numbers are shown for each category.
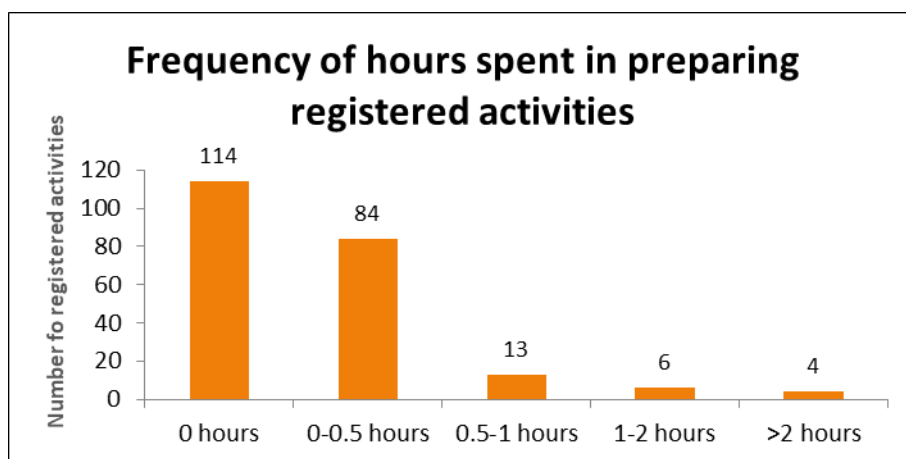


**Figure 4.23. Time spent in preparing registered educational activities.** Absolute numbers are shown for each category.

Overall, considering the logbooks of the 10 RFs, RF staff dedicated 381 hours to educational activities during the six weeks. They needed 68 hours (18%) to prepare registered activities and 313 hours (82%) to actually develop their content.

Times and preparation times required for registered activities were added together according to their content (**Figure 4.24**). These time calculations were just rough estimations because for each registered activity there was just one value of time and preparation time, but they included one or more different types of content. For example, if a single activity included training in *experimental design* and *sample preparation* and lasted for one hour, I could not know how much of the hour was dedicated to each training. For the calculations, in the case of this example, one hour was added to *experimental design* and one hour was also added to *sample preparation*.

By having a look at the proportion of preparation time required in relation to the total amount of time (preparation time plus time) recorded in registered activities depending on their content, it is interesting to see how activities involving more intellectual work, i.e. experimental design, data interpretation, and theory, required a higher relative preparation time (percentage preparation time/total time were 23%, 25%, and 22%, respectively) compared to activities involving more routine or practical steps, i.e. sample preparation and instrument use (percentage preparation time/total time were 18% and 16%, respectively). Thus, despite many activities were directly related to the use of instrumentation, those were not the ones requiring more effort.
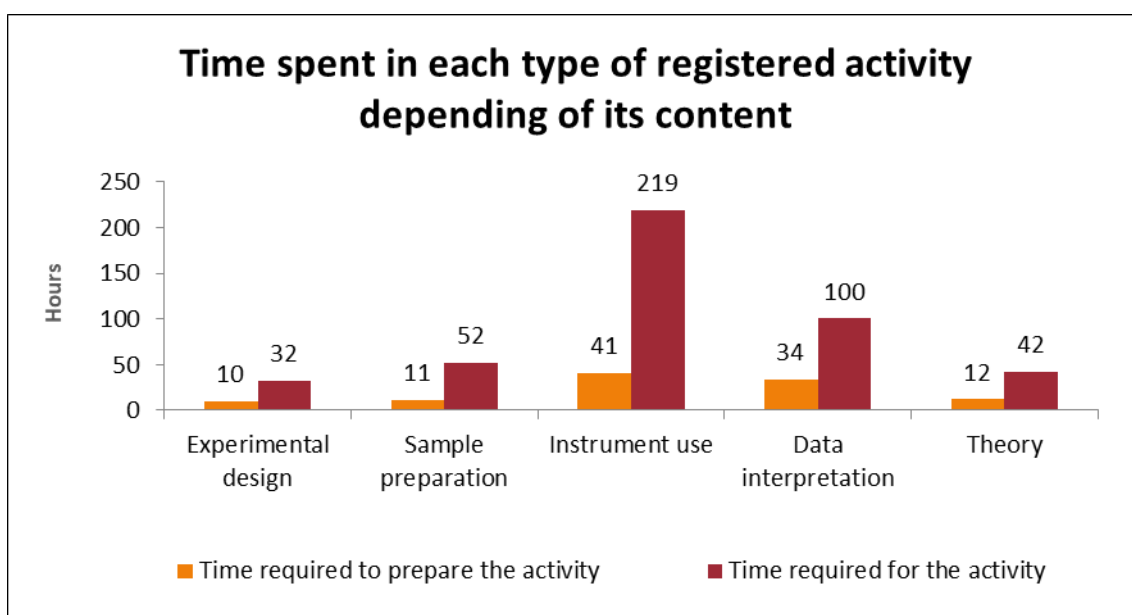


**Figure 4.24. Time spent in registered activities in relation to their content.** Absolute numbers are shown for each category.

Regarding the number of staff involved in each registered activity (**Figure 4.25**), in only 8 of the 221 logbook entries, two members of staff were recorded instead of one. For these cases, the type of interaction was described as one to one, suggesting that the two members of staff took turns at different stages of the process instead of interacting simultaneously.
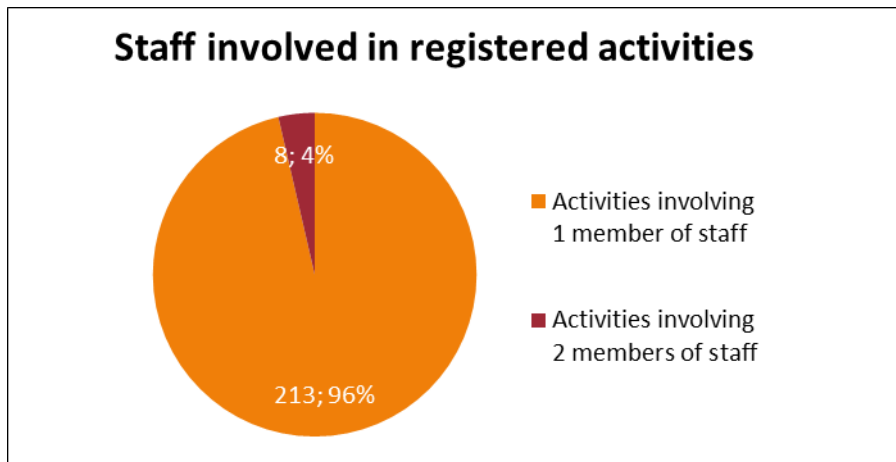
**Figure 4.25. Members of staff involved in registered activities.** Absolute and percentage numbers are shown for each category.

Finally, in agreement with the content of registered activities and the support given to users, more than half (57%) of the activities included the use of one, two or three major pieces of instrumentation (**Figure 4.26**).
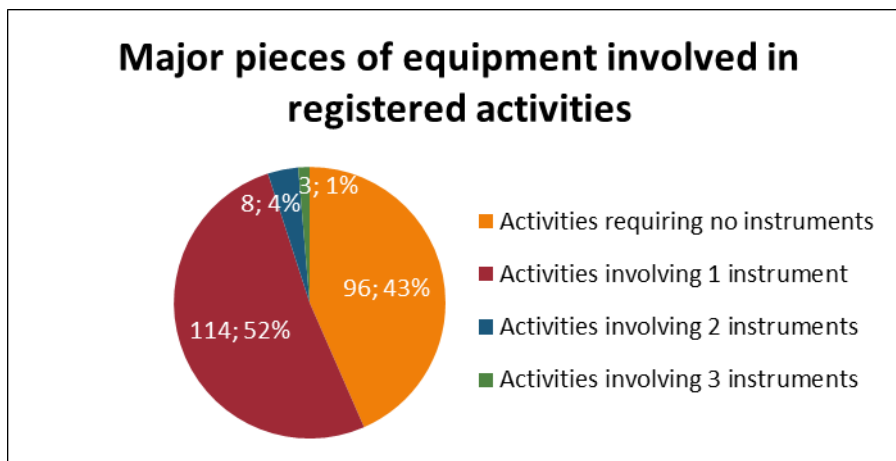


**Figure 4.26. Number of major pieces of equipment involved in registered activities.** Absolute and percentage numbers are shown for each category.

Briefly, regarding the resources used for educational activities in RFs, in terms of time, 75% of activities lasted within the hour, 45% required preparation time, which was in 78% of the cases less than 30 minutes. Activities with content involving more intellectual work (experimental design, data interpretation and theory) required a higher amount of preparation time compared to those involving more routine technical work (sample preparation and instrument use). Only 4% required more than one member of staff and 57% included the use of a major piece of equipment.

## 4.6. IMPORTANCE AND BENEFIT OF EDUCATIONAL ACTIVITIES IN RFs

Respondents of the questionnaire were asked about how important or beneficial was the use of RFs in relation to three elements: their research project (**Figure 4.27**), the support provided by RF staff (**Figure 4.28**), and their professional future (**Figure 4.29**).

Regarding how important the use of RFs was for the respondent's research project (**Figure 4.27**), 89% (107 of 120) of responses indicated that RFs were *Very important* as the project could not be carried out without using the RF. None of the responses indicated that using RFs was *Not important* and users could continue their research projects without the RF. This result highlights the essential role that RFs have for the development of RF user's research projects.
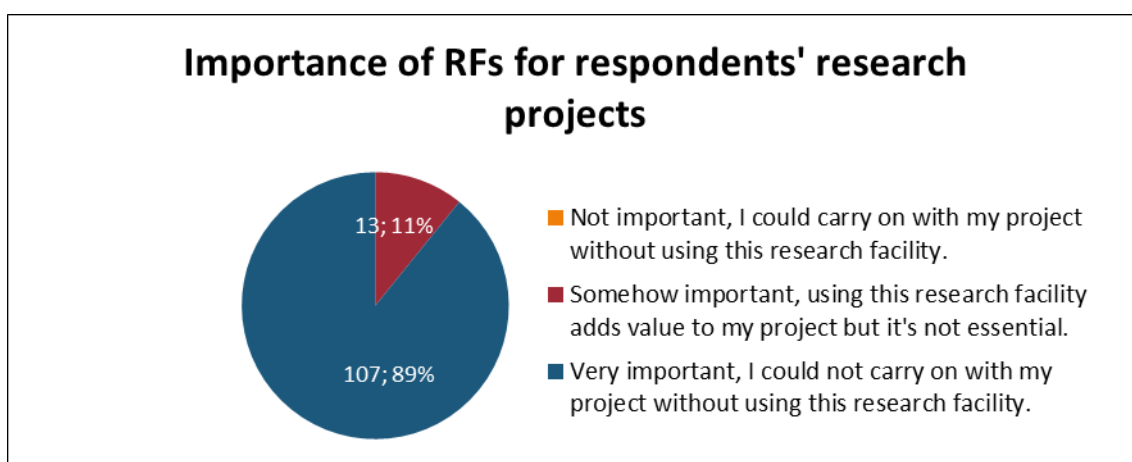


**Figure 4.27. Importance of RFs for respondents' research projects.** Absolute and percentage numbers are shown for each category.

In terms of how important the support from RF staff was for respondents (**Figure 4.28**), only 2% (2 of 120) of responses indicated that RF staff support was *Not important* because users were knowledgeable and independent in the use of RFs. These two responses corresponded to PhD students from different departments at the University of Sheffield who answered *Very important* to the question regarding the use of the RF for their research projects. The rest of responses indicated that RF staff support was either *Somehow important* or *Very important*, recognising the specialised skills and knowledge that RF staff require and use in their interactions with users.
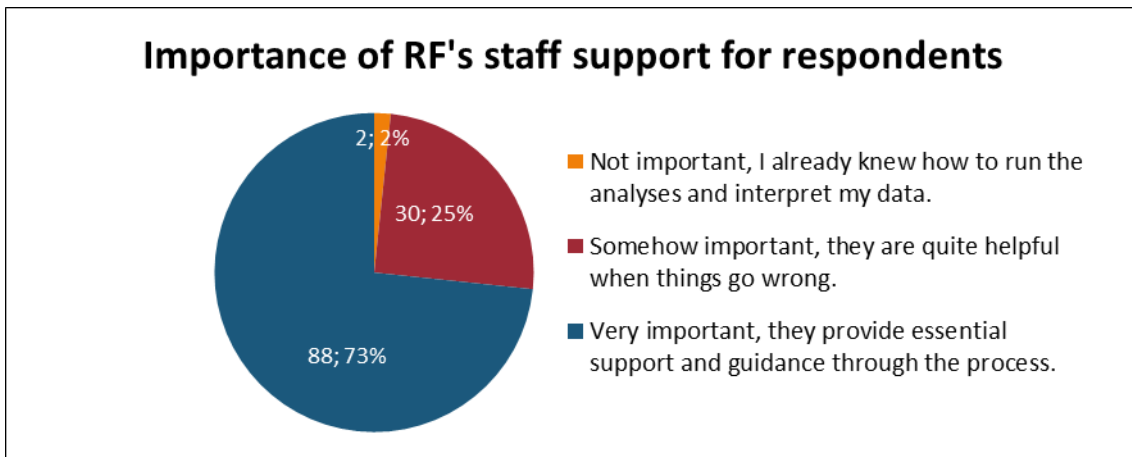
**Figure 4.28. Importance of RF's staff support for respondents.** Absolute and percentage numbers are shown for each category.

Finally, 2% (3 of 120) of responses indicated that users did not learn anything new that they could add to their CV (**Figure 4.29**). None of these came from the same questionnaire responses selecting that RF staff support was *Not important*. In this case, they corresponded to one Master's student and two PhD students from different departments, selecting either *Very important* or *Somehow important* in previous questions. The Master's student reported that the content of the support that she/he received was *None of the above*, while the two PhD students reported being trained in the use of instrumentation and being taught theory.
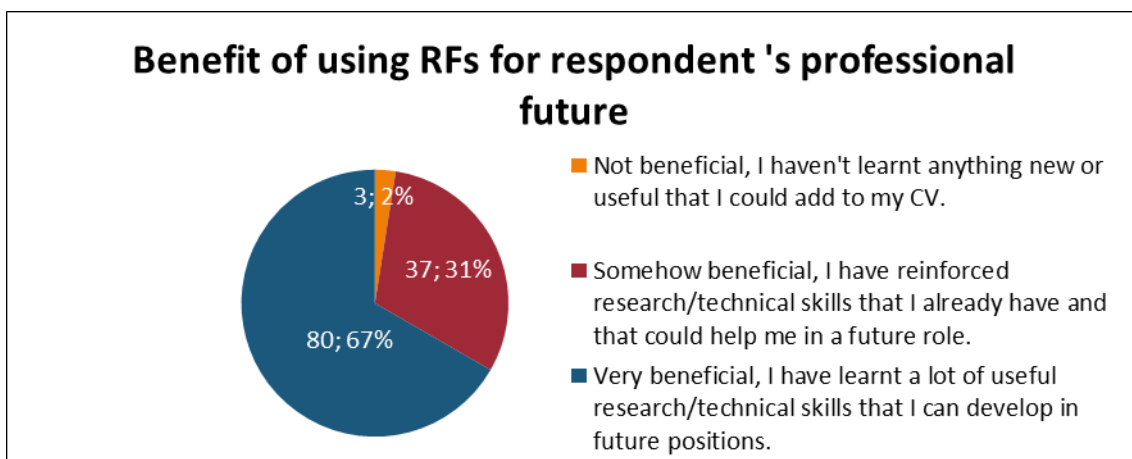


**Figure 4.29. Benefit of using RFs for respondent's professional future.** Absolute and percentage numbers are shown for each category.

The remaining 31% (37 of 120) and 67% (80 of 120) of responses indicated that using the RF was respectively *Somehow beneficial* and *Very beneficial* for users since they have reinforced or learnt many skills that could be developed in future positions. Thus, regarding the preparation of users for future positions, RFs seemed to have a significant educational role for respondents.

To summarise, and focusing on the highest importance given by respondents, 89% of respondents indicated that they could not carry on with their projects without using the RFs, 73% indicated that RF staff provided essential support and guidance through the process and 67% indicated that they have learnt a lot of useful research/technical skills that they can develop in future positions.

## 4.7. RFs IN THE EDUCATION OF PG STUDENTS AT THE UNIVERSITY OF SHEFFIELD

This final section of the findings focuses on the interactions between RFs and PG students from the University of Sheffield, the major group of users involved in educational activities according to findings presented above. The number of PG students involved in educational activities over time (**Figure 4.30**) followed the same distribution as the total population (**Figure 4.5**).
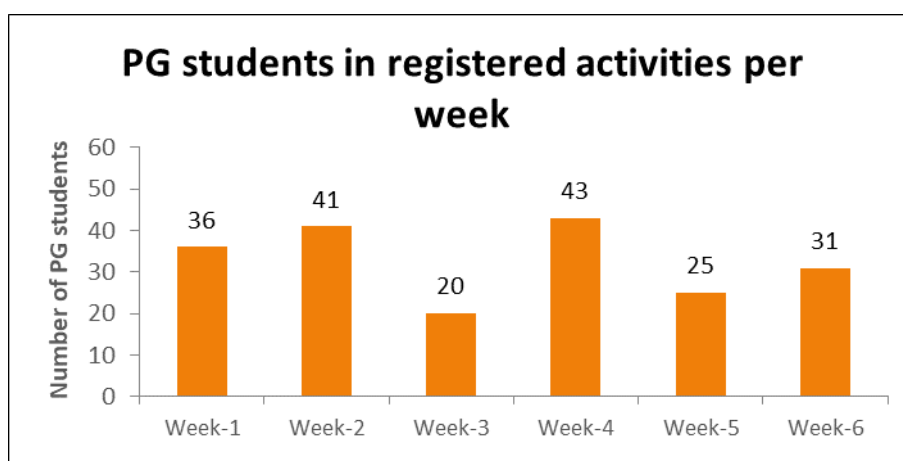


**Figure 4.30. Temporal distribution of the 196 PG students from the University of Sheffield involved in registered educational activities.** The number of PG students reported by all RFs is represented.

A total of 177 educational activities reported in logbooks involved PG students, accounting for 196 users and representing 75% (196 of 263) of total users reported in registered activities (**Figure 4.31**). The population of PG students was distributed 86% PhD students (168 of 196) and 14% Master's students (28 of 196). Regarding the questionnaire, PG students represented 71% (85 of 120) of total respondents (**Figure 4.32**), from which 75 (88%) were PhD students and 10 (12%) were Master's students. These 85 PG students were distributed across departments (**Figure 4.33**) similarly to the whole population of respondents (**Figure 4.12**). Chemistry students represented half of responses, followed by Molecular Biology and Biotechnology with 25%. Most departments from other departments outside the Faculty of Science represented by the whole population were also represented in the PG student population. Archaeology was not represented and left out the Faculty of Arts and Humanities in this subset of data.
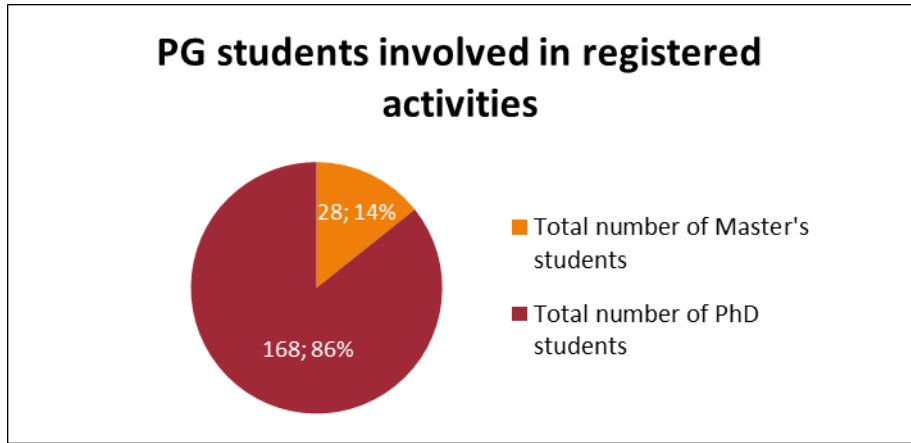
**Figure 4.31. Distribution of PG students from the University of Sheffield in registered educational activities.** Absolute and percentage numbers are shown for each category.
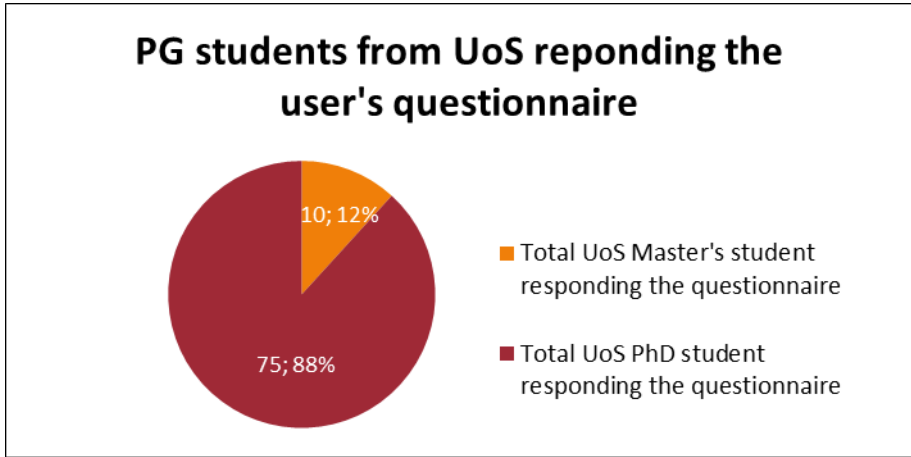


**Figure 4.32. Distribution of PG students from the University of Sheffield (UoS) amongst questionnaire responses.** Absolute and percentage numbers are shown for each category.
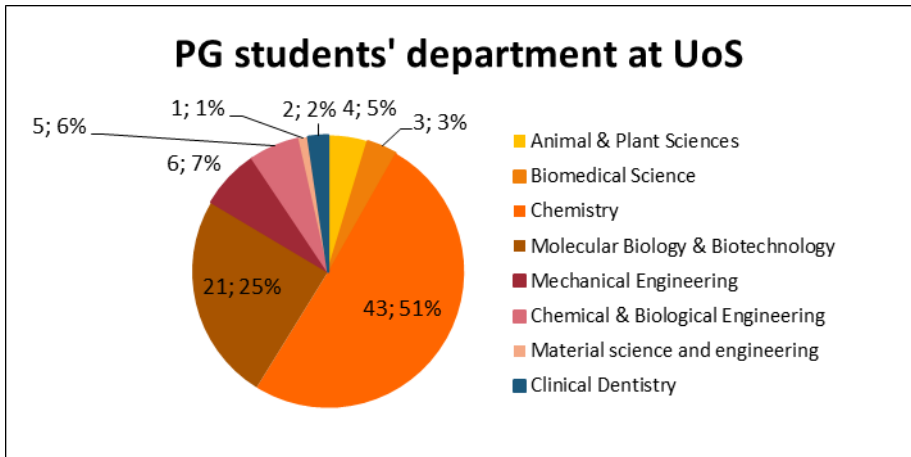


**Figure 4.33. Departmental representation for questionnaire responses from PG students from the University of Sheffield (UoS).** Absolute and percentage numbers are shown for each category.

The content of the 177 educational activities registered in logbooks involving PG students covered all areas that the whole population covered except for theory teaching. However, 43% (37 of 85) of questionnaire responses from PG students indicated being taught theory. Training in the use of instrumentation was again the most represented in both datasets for PG students. Time invested in these activities represented 86% (326 of 381 total hours) of total time reported for educational activities (**Figure 4.34**). Preparation time corresponded to 57 hours and time spent in activities accounted for 269 hours, following the same proportion (18% and 82%, respectively) than for the whole population of users registered in educational activities (section 4.5).
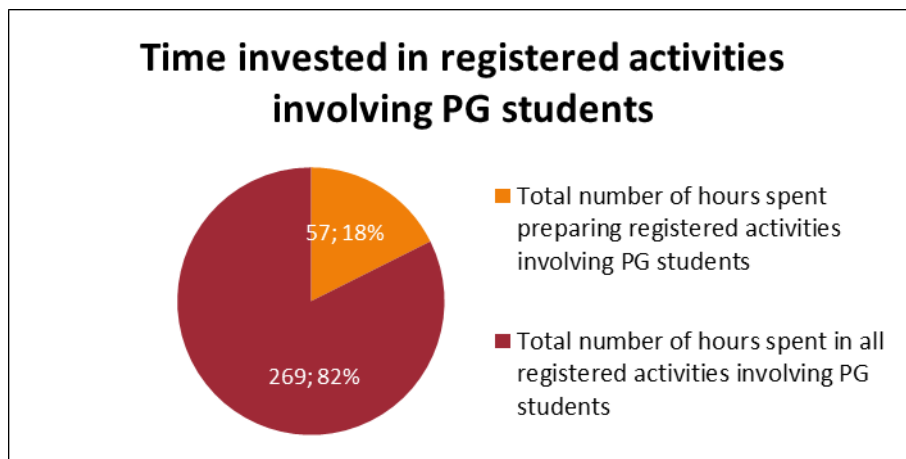


**Figure 4.34. Time invested in registered activities involving PG students.** Absolute and percentage numbers are shown for each category.

Regarding the importance and benefit given to the use of RFs, the results of the questionnaire for PG students showed a slightly different tendency than the whole population of questionnaire respondents. An astonishing 92% of responses from PhD students indicated that they could not carry on with their research project without using RFs (**Figure 4.35**). In the case of Master's students, the equivalent group of responses represented 80%. Both groups, Master's and PhD students, showed the same distribution of responses regarding the importance of RF staff support (**Figure 4.36**). Around 70% of them indicated that RF staff support was *Very important*, a slightly lower proportion than the whole population of respondents, which was 73% (**Figure 4.28**). Two PhD students indicated that they were independent in the use of RFs and this support was *Not important*. Finally, while PhD students showed a distribution closer to the general population (**Figure 4.29**) of respondent and 64% of them attributed *Very beneficial* to the use of RF for their professional future, Master's students showed a lower tendency and only 50% of them gave this response (**Figure 4.37**). As mentioned in previous section (section 4.6), three PG students indicated that using RFs was *Not beneficial* for their professional future as they did not learn anything new that they could add to their CV.
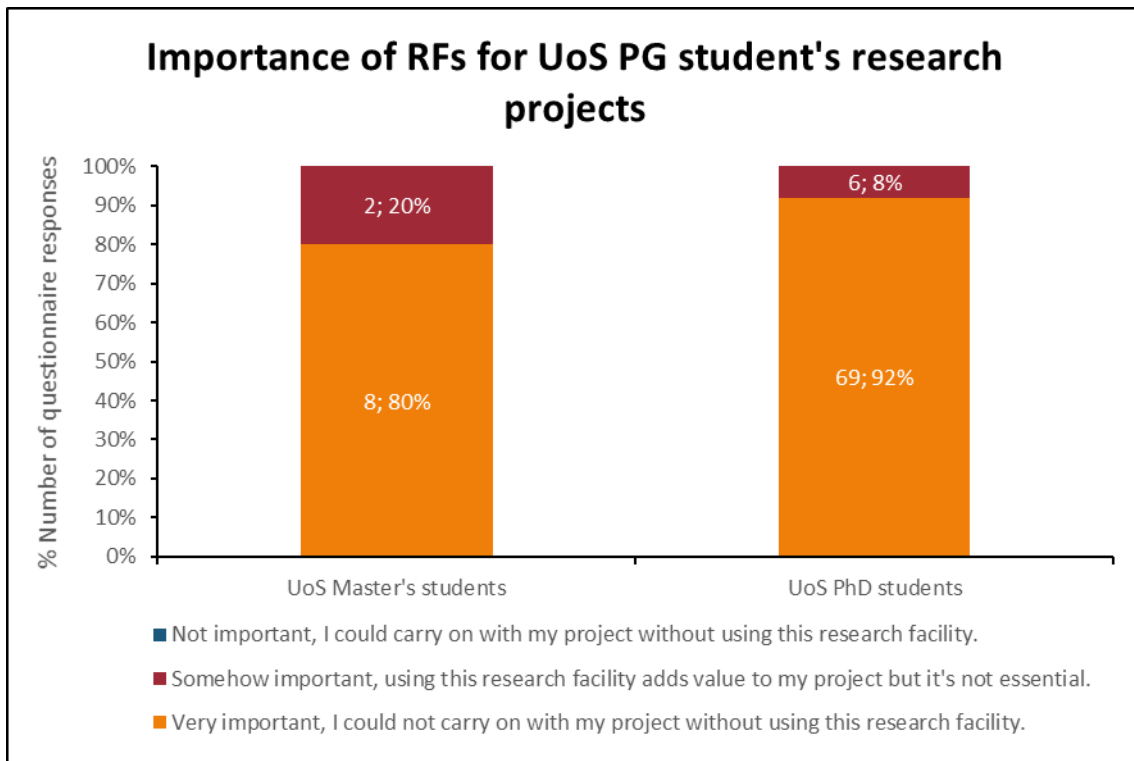
**Figure 4.35. Importance of RFs for research projects of PG students responding to the questionnaire.** Absolute and percentage numbers are shown for each category.
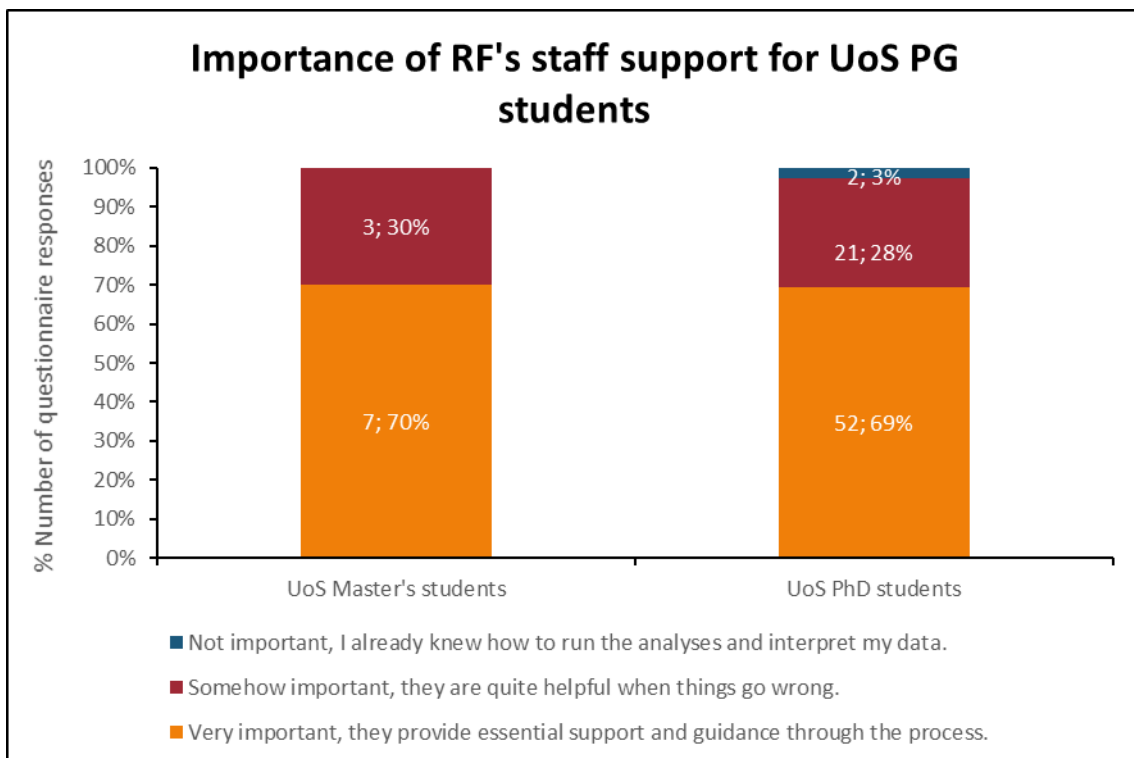


**Figure 4.36. Importance of RF's staff support for PG students responding to the questionnaire.** Absolute and percentage numbers are shown for each category.
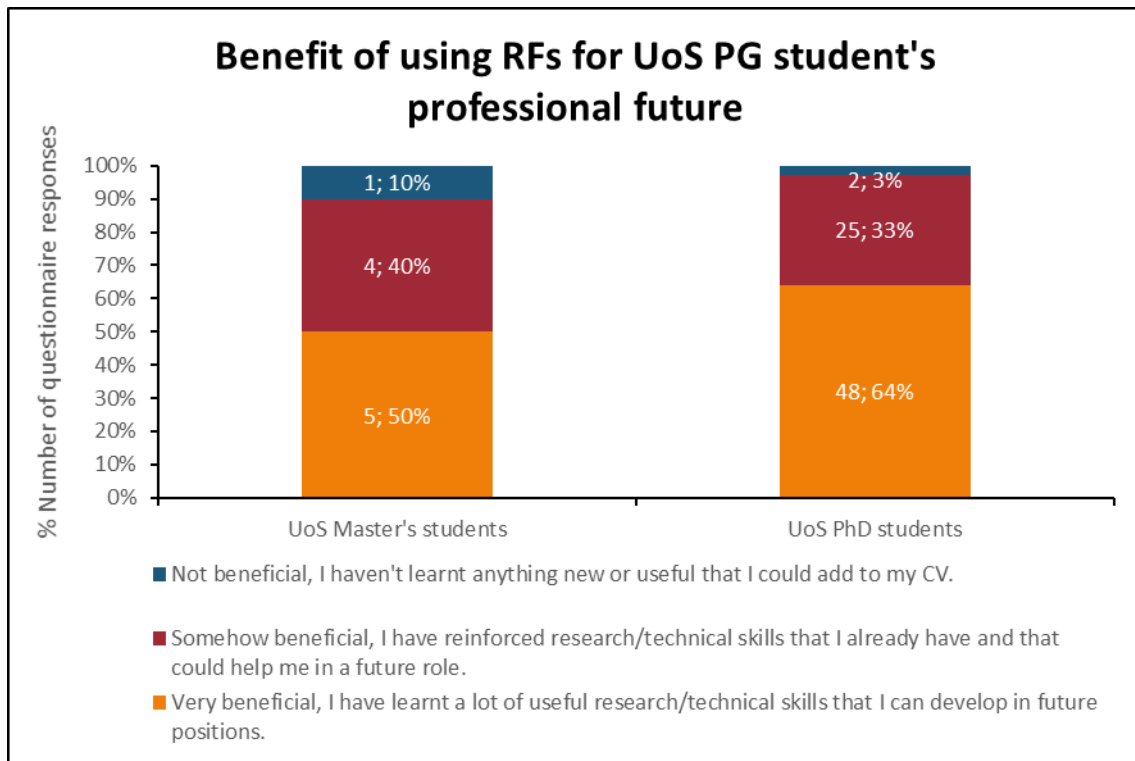
**Figure 4.37. Benefit of using RFs for the professional future of PG students responding to the questionnaire.** Absolute and percentage numbers are shown for each category.

The profile of these responses from PG students suggested that the more advanced they are in their studies, the more important become what they learn and how they learn it, which is probably aligned with the maturity acquired over the years of study. Generally, RFs showed to have an important role for users participating in the study independently of their status and seemed to have a higher impact for PG student research projects.

In this section having a look at findings related to PG students from the University of Sheffield, the summary is that around 75% of all users involved in educational activities in RFs are PG students. From these, approximately 88% are PhD students and the rest are Master's students. The time that RF staff invested in activities involving PG students represented 86% of the total time reported. Regarding the importance given to RFs, 92% and 80% of PhD and Master's student, respectively, indicated that RFs were very important and they could not carry on with their projects without using the RFs. Around 70% of both PhD and Master's student indicated that RF staff provided essential support and guidance through the process. Finally, 64% and 50% of PhD and Master's student, respectively, indicated that they have learnt a lot of useful research/technical skills that they can develop in future.

# * 5. DISCUSSION *

In this section, I firstly discuss the results from the perspective of the aims of the dissertation project and address research questions (**section 2.4**). Secondly, limitations of the project are pointed out as well as recommendations for future research in this area. Finally, I explore the impact that going through this research has had on a more personal level.

## *5.1. CONTRIBUTION OF RFs TO EDUCATION*

The findings of this research demonstrate that RFs contribute to the education of users with a diverse set of activities aiming at providing users with independent access to instrumentation and at making them critical evaluators of the acquired data. This was the underlying hypothesis of the research, addressing one of the research aims of the study. In relation to research question **QA - What resources in RFs are used for education-related activities?** activities described by RF staff and users included teaching of theory, experimental design, training in sample preparation, training in the use of instrumentation and data interpretation. The perception of users was more evenly distributed across these categories of content than the perception of RF staff, which was biased towards training in the use of instrumentation. This might suggest that RF staff see their jobs as more technical and instrument driven rather than providing education, while users appreciate the interaction as a learning experience and are more aware of the information that they are receiving. This biased perception of RF staff in relation to their roles could originate in the general view of RFs as concentrations of equipment capital for research, and without any relationship with teaching or learning. However, major pieces of equipment were used in around half of the activities, which also implies that the other half were not directly related to the use of instrumentation and corroborates the data about the content of the activities. The relationship between time invested in preparing and developing these activities varies in relation to their content. More routine technical activities required lower preparation time compared to more intellectual ones, often defined by the specificity of user's research projects. This suggests that despite RFs are built around the sharing of equipment (Jackson, 2013), their scope is much wider during the research process. There was an important range of diversity in the amount of educational activities carried out across participant RFs, spanning from five to 48 during a period of six weeks, which indicates that the training of users is not a standard and regular practice in all RFs. Additionally, all activities were classed as non-formal and the vast majority were one to one sessions, highlighting the high ratio of human resources dedicated to non-recognised learning activities.

Regarding research question **QB - How beneficial are these education-related activities for the users of RFs?** RF users represented a relevant diversity of population that benefited from educational activities and included: both UG and PG students, postdoctoral researchers, technical and academic staff as well as external users from other universities and industry, although the latter group of external users just represented less than 3%. Despite all participant RFs were hosted by the Faculty of Science and this was the most represented faculty amongst users, the faculties of Engineering; Medicine, Dentistry & Health; and Arts & Humanities were also represented by users from multiple departments. These data show the multidisciplinary impact of RFs, by pointing at the diversity of research projects requiring their use and the wide range of users involved in such projects, who additionally enhance their learning through the access to RFs as direct users instead of in a service manner. Three questions were asked to these users in order to understand the deeper level of impact that using RFs were bringing to them. First, when asking these users how important the use of the RF was for their project, almost 90% responded that RFs were very important because they could not carry on with their project without using these RFs. Second, users were asked how important was the support of RF staff for them and 73% of their responses indicated that RF staff was very important because they provide essential support and guidance through the process of using the RF. Third, they were asked how beneficial was the use of the RF for their professional future, and 67% of them estimated that it was very beneficial because they have learnt a lot of useful research/technical skills that they can develop in future positions. Responses to these questions place RF as relevant spaces from three strategic points of view. The first one is their key role as resources for research development that otherwise, will not be achievable. It is important to acknowledge at this stage that of course not al research projects require the use of RFs, but when they do, RFs become essential. This is supported by the fact that around half of users were regular users of the same RF. The second point of view refers to the key labour of RF staff. They have a complex non-academic role and make the most of their technical knowledge and experience to enhance research (default view of RF staff jobs). They also support users in their access to RFs with dedicated non-formal training sessions that can involve diverse content and resources, and serve as valuable educational experiences for users. The third point of view places RFs as an important environment to develop users' employability by developing and reinforcing their research and technical skills. It would be interesting to understand why users thought that what they learnt in RF would be useful in their professional future. Do they have a clear idea of what they want to pursue as a professional career? Are they aware of possibilities in academia and industry that require these skills? They will certainly help in any research position, but do they all think that they will be holding a research position in the future? The current research data do not allow to answer these questions.

## 5.2. ROLE OF RESEARCH FACILITIES IN THE PG CURRICULUM

Data from this research identifies PG students as the major population of users receiving education in RFs, representing up to 75% of total trained users. Within this group, a vast majority were PhD students. Discussions with RF staff during this study pointed out that PG students are also the major group of RF users as a service, although I do not have evidence to support this statement. Half of these students were from the Chemistry department, indicating that, even within the natural sciences, there might be disciplines for which RFs are more important, but this could also be a consequence of the major group of participant RFs being from the Chemistry department. These results confirm Chiang's (2011) observations about the importance of RFs for PhD students in relation to disciplines and subject matters. The importance of the role of RFs and technical staff for doctoral learning in the natural sciences has been described in previous studies (Vekkaila et al., 2012 and Kemp et al., 2014). However, the current research offers a deeper understanding of what are the elements responsible for such importance, focussing on: research projects, RF staff support and preparation for future professional positions. PG responses in regard of these three aspects were similar to the whole population of users and explained above. Still, it is worth mentioning that a striking 92 % of PhD students indicated that they could not carry on with their project without the use of RFs. This single piece of information should be enough justification to provide a role for RFs in the PG curriculum. In my preliminary study, RFs at the in the Faculty of Science were perceived as playing an essential role in different aspects of teaching/training (Acosta-Martin, 2019). This perception is now supported by evidence. A couple of ideas come to my mind in order to shape the role of RFs in PG research education. One could be as part of the wider picture of the PG student learning partnership as a direct actor involved in the transfer of knowledge. Another could be in a more indirect way as a space provider to develop communities of practice and support peer-peer learning. PG students using the same RF are inevitably connected by the technical specialisation of the RF. This element could be a useful common interest to build those communities of learning and support, bringing together PG students from across different disciplines, helping them to broaden their scientific knowledge. Currently, the University is planning changes for PG research programmes (The University of Sheffield, n.d.b.), offering a timely opportunity to acknowledge and develop these roles of RFs to enhance PG learning.

## 5.3. LIMITATIONS OF THE RESEARCH

Like every research, this dissertation also had its limitations. For a novel area of research like this one, quantitative data allows having a first overview of the situation under study, which can help

in guiding future research into more precise aspects. However, the use of quantitative data, allowing a more general approach to the research questions, cannot reach the depth of understanding of qualitative data. This lack of qualitative information was compensated in the user questionnaire by including informative responses that allowed a limited degree of qualitative interpretation.

Due to the use of anonymous questionnaire responses, another limitation of the study regards the lack of identification of repeated responses from the same user. Having this additional information would have allowed tracking the perception of users about their learning over time after multiple uses of the same RF. One way to overcome this would have been to record user's email addresses in questionnaire responses and anonymise them as part of data treatment. Another way could have been to ask in the questionnaire additional questions like these "Have you already answer this questionnaire? If your answer is yes, how many times?", which would keep participants anonymity from the beginning but still allow some chronological interpretation of the data.

Additionally, these findings are specific to the circumstances of the study, mainly defined by the identity of RFs participating in the study and the particular period of time when data collection took place. It is possible that inclusion (and of course exclusion) of other RFs in the study would have shown a more (or less) diverse set of educational interaction with different impact. They are also specific to the University of Sheffield. Recently and timely (June, 2019), I attended a small conference where I could discuss with RF managers from other research-intensive universities in the UK. I realised how much the financial pressure hold by RFs to generate income was affecting the way of running their RFs and contributing to stress. Some of these RFs are not *allowed* to analyse any single sample without charging, not even a test sample or for acquiring preliminary data to include in grant applications. Others work very much in a service manner, excluding the possibility of training and direct instrument access to users. As a higher education institution, even being research-intensive, quality educational interactions should be promoted and rewarded instead of restricted and penalised. The current study cannot clarify whether RFs reporting a low number of activities did it because the general activity of the RF was low during that period, because users were trained in past events and accessed the RF in an independent way or because they do not regularly practice user's training but mainly work in a service manner.

## 5.4. RECOMMENDATIONS FOR FUTURE RESEARCH

This piece of research offers empirical evidence to support the value of RFs not only through their contribution to research, but also through the contribution that they make to education, and more precisely, to PG education, which also has an intrinsic connection to research. More research is

needed to understand how RFs fit within the higher education system and directions for future studies are countless. However, in my view, and given the findings from the present study, there are three main directions that could be given priority:

- To understand how RFs work in other research-intensive higher education institutions and what the benefits and drawbacks are for promoting the view and practice of RFs as valuable educational environments. Are RF's educational practice similarly diverse in other institutions? Is this educational work recognised? These studies could be used to understand the diversity of practices, and to inform the implementation of support and recognition of RFs across the sector.

- To understand the role of RF staff in such environments and how they perceive themselves and their interaction with users. While they are certainly prepared for the technical side of their job, do they feel prepared to train individual users adequately? What are their motivations to be more educational than service driven? As already mentioned, priority to a service manner of working could originate from financial pressures. Additionally, it could also come from high levels of workload due to increased numbers of demanding research projects that require sample analysis and results as soon as possible. Inevitably, education takes time.

- To understand how RFs could enhance the learning of PG research students, and play an important role in the complex network of learning partners beyond the relationship of students with their formal supervisors. What are the most valuable features of learning in RFs for PG students? Are there ways of improving this learning interaction? Could RFs be developed as spaces for the implementation of learning through communities of practice? In this regards, there is a lot of potential opportunities to be explored, including opportunities for the development of peer learning.

## 5.5. PERSONAL IMPACT OF THIS RESEARCH

This project originated as a personal enquiry that has found some hopeful and helpful answers across the way. To me, understanding the educational role that RFs play at the university has become a key piece of information to understand my own role and to make a positive influence in its development. Coming from a scientific background in the natural sciences, this educational work, together with the rest of the MEd experience, has represented a true challenge. Research in the social sciences is "more tricky" because the researcher is central to the process and has an important subjective contribution to the perspective and interpretation of the research, and therefore on the actual results, while in the natural sciences, although the researcher is also essential in the research process, the results must be independent of his or her subjective opinion. In the natural science, we

tend to approach the objects of research as isolated elements, one would never apply a similar approach in the social sciences where individuals, their perceptions and interactions are very diverse and extremely relevant for the interpretation of research. I have perceived this subjectivity as a positive element contributing to the richness of the subject rather than a hindrance for progress. Participating in this MEd programme and developing a research project has also been useful to delve into my own nature as a researcher and as a human being, and it has helped me clarify the rank of priorities in my professional environment in relation to my personal values. I feel better prepared to have a critical view on higher education systems and to approach them from a scientific point of view.

In **section 3.2**, I mentioned my main motivations to carry out this project and to do it in the way that I did. I think that, at least, I have started the process to develop what I wanted to achieve: 1) I do have now a better understanding of my own role, 2) I have gathered evidence for the educational work carried out in RFs and I will be working in the near future to make that work recognised, increasing the opportunities for professional development of RF staff, 3) I have contributed to make a more cohesive network of RFs' staff, and 4) by developing this work, I hope to improve the support given to RF users and particularly the learning of PG students from a more general perspective in the Faculty and wider university, but also in my daily work in the RF. This is just the starting phase of a longer process in which I have played the role of a spark starting the ignition of a fuse. There is still a long way to go that relies on a more collective responsibility of engaged action and that will define whether the flame extinguishes halfway through the fuse or keeps on going and delights us with some powerful and colourful fireworks.

# * 6. CONCLUSION *

The conclusion of having done this work is realising that PG students as a group, possibly being one of the largest bodies of researchers in the institution and constituting an essential and irreplaceable part of the university's research human capital, are also the major group of users in RFs, which in turn, host and account for the largest part of research capital equipment. Therefore, these two actors of the higher education research scene, PG students and RFs, could be described respectively, as extremely valuable human and technical research engines. The interaction between PG students and RFs can be highly variable; there are PG students that do not require the use of RFs for their research projects, there are those that use RFs as a service and those that participate more actively in their interaction with RFs, enhancing both their education and their research projects. Given the importance of their roles, whenever there is an interaction between RFs and PG students, making it open, confident and collaborative will be the most beneficial situation for the quality of research outputs.

In my experience, current factors impeding the improvement of these interactions relate to the financial pressure that RF staff receive in order to generate at least, a break-even income. Because of this pressure, many of us would prefer to interact with users in a *service* manner rather than in a *training* manner, in order to maximise the number of analysis, and therefore the income. Additionally, most users, including the users that access RFs as a service, are PG students (conclusion reached after discussion with my peers when sharing the results of the study with them), who unfortunately are the users with the lowest funds in their research budgets. As a consequence, it is very often the case that we can not apply the fEC rate for charging their analysis but a lower one, or even sometimes, we do not charge at all. One possibility to overcome this financial problem would be to increase the budget of PG student's projects so we can apply the fEC rate and increase our income in RFs. Another possibility can be to use the evidence about the value of RFs as educational environments provided by this dissertation as a justification to deviate some "teaching funding" to RFs. These changes would alleviate the financial struggle of RFs and will help RF staff to use more resources for the interactions with PG students.

Another factor hindering the development of these educational interactions is the lack of tailored professional development for RF staff. There are not many other roles at the university with the singularities of being RF staff. We are hired by our technical skills, and unless we held a similar position in the past, all the other abilities are acquired on the job, including the one to one training of users. Academic staff benefit from multiple types of training sessions to improve their educational

skills, although generally, a major emphasis goes to UG teaching. Thus, academic supervisors of PG students also encounter difficulties in an adequate training to supervise PG students. While many of them attend mandatory training programs to develop their supervising skills (Manathunga, 2005; Lee, 2018; Pearson and Brew, 2002), these do not always address the complexity of the supervision relationship and focus solely on the administrative part of the role. Even less opportunities are given to professional staff, who may require more specialised sessions. I wonder whether it would be possible to recognise educational activities in RFs more formally. This will help to put in place some of the required support. RF staff needs more support to keep raising the profile of the education given to our PG students and therefore of our research. Additionally, it might also help PG students to be recognised for what they have learnt with us, improving their professional profile for a future position.

I will encourage the Faculty of Science, and the University of Sheffield to consider the implementation of some of these aspects and make a win-win-win situation for research, for PG students, and for RF staff. In order to take this project forward and make changes I have plenty of ideas that I would like to carry out in the following months:

- **Internal dissemination of this work**
    - o To share current version of the dissertation with participant RF staff.
    - o To generate a reduced version of this dissertation that can be widely distributed amongst staff and students within the Faculty of Science.
    - o To adapt the information of the reduced version so that it can be included in the collective RF's webpage in the Faculty of Science.
    - o To advertise the results and a future publication in the RF's webpage through the main webpage for staff at the University of Sheffield: https://www.sheffield.ac.uk/staff
    - o To present this project in one of the weekly seminar meetings in the department of BMS, host of the RF where I work.
- **External dissemination of this work**
    - o To prepare a journal article from this dissertation that can be publish in a relevant journal.
    - o To get in touch with the N8 Research Partnership and share these results with them so they can be distributed in other institutions.
- **Driving change**
    - o To organise a meeting with Faculty of Science leadership group, heads of departments and other key members of staff from the wider university (involved in the University Executive Board, finance, communication, staff development, PG education, impact,

and research services) in order to present this research, its importance, propose the above mentioned changes and open a discussion that will allow their implementation.

In light of this conclusion, I would like to end up with a caveat on the practical implications of considering RFs as educational environments as part of their *default role*. Given the diversity of requirements and practices linked to the variety of equipment hosted in RFs, it will be a mistake to attempt the standardisation of their practice, which is different from aiming at a high quality (but diverse) practice. RFs are not just about instrument and their shared used. Their idiosyncratic nature is also defined by the resources accompanying such equipment, including laboratory and data analysis space, time and number of staff, knowledge and support available. Time resource is possibly the one element that RF staff concentrate and stretch the most, depending on the other resources. RFs have emerged to increase research efficiencies by sharing equipment and higher institutions and administrations should be careful about keep pushing this concept of efficiency, which in turn, could be detrimental for the quality of the work carried out in RFs.

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# * 8. APPENDICES *

## 8.1. Information collected in the logbook of RF's teaching/training activities

0.  Date
1.  Research Facility Code
2.  Teaching/training activity (One-to-one training, Theoretical course, Practical course, Other (specify))
3.  Brief description of the activity
4.  This activity is... (Officially / formally recognised, Non-official / Non-formal)
5.  How many facility staff were involved in the activity?
6.  How many hours/days did you need to prepare the activity?
7.  For how many hours/days did the activity last?
8.  How many and what kind of users were involved in the activity? (Master's Students, PhD students, Postdocs, Academics, Professional staff, other)
9.  How many major pieces of equipment were involved in the activity?

Additional comments / Absence

## 8.2. Example of email inviting users to fill in the questionnaire for the first time (send after Week-5 of data collection)

Good morning!

And **THANK YOU** for agreeing to receive this email!

I'm inviting you to participate in a small research study that is part of my Master's in Teaching and Learning in Higher Education at the University of Sheffield. **The project aims at assessing what is the teaching contribution of Research Facilities in the Faculty of Science in order to enhance their value as active educational environments**.

You will need to fill in an online questionnaire about the Research Facilities that you have used in the last couple of weeks. It will take less than 5 minutes to do so. **It would be perfect if you could fill in the questionnaire by the end of the current week**.

Participation is entirely voluntary. If you decide to take part in this study, your participation will be completely anonymous, as personal data, including which research facility you have used, will not be recorded. By doing this, I am trying to encourage participants to be as honest as possible in order to collect data that truthfully represents the reality.

Attached is the participant information sheet, where you can find more details about the project, and this is the link to the questionnaire: https://forms.gle/ya3QdHpaHaTWpvVV7

Below is the list of Research Facilities participating in the study. If you have used more than one, please fill in 1 questionnaire *per* facility. After submitting the first time, you will find a link to submit a new response.

We are collecting data until the end of this week (26th April). If you are using any of the research facilities again before Friday and you are willing to participate, you will receive this email again, please fill in new questionnaires for each time that you receive this email.

- Biomolecular NMR Facility (MBB)
- Electron Microscopy Unit (BMS)
- Electron Microscopy Unit (MBB)
- chemMS - Mass Spectrometry Centre (CHM)
- Metabolomics - Mass Spectrometry Centre (APS)
- Proteomics - Mass Spectrometry Centre (BMS)
- Spectroscopy & Chromatography (CHM)
- Surface Analysis Centre (CHM)
- X-Ray Crystallography (MBB)
- X-ray Crystallography (CHM)

This study has been approved by the School of Education Ethics Review Panel (Application Reference Number 024728). If you have any questions about this study, please get in touch with me: a.acosta-martin@sheffield.ac.uk

Thanks a lot and have a nice day,
Adelina

## *8.3. Example of email inviting users to fill in the questionnaire again (send after Week-5 of data collection)*

Hello! I hope you had a great Easter weekend and could enjoy the weather!

As you might be aware from my previous emails, you are receiving this again because during last week you used again one or more of the research facilities participating in the study:

- Biomolecular NMR Facility (MBB)
- Electron Microscopy Unit (BMS)
- Electron Microscopy Unit (MBB)
- chemMS - Mass Spectrometry Centre (CHM)
- Metabolomics - Mass Spectrometry Centre (APS)
- Proteomics - Mass Spectrometry Centre (BMS)
- Spectroscopy & Chromatography (CHM)
- Surface Analysis Centre (CHM)
- X-Ray Crystallography (MBB)
- X-ray Crystallography (CHM)

Just a reminder that this is a small research study that is part of my Master's in Teaching and Learning in Higher Education at the University of Sheffield. **The project aims at assessing what is the teaching contribution of Research Facilities in the Faculty of Science in order to enhance their value as active educational environments**. Your participation is entirely voluntary and completely anonymous. Personal data, including which research facility you have used, will not be recorded.

As I did last time, if you decide to participate, I'm asking you to fill in an online questionnaire about your experience in the Research Facilities that you have used since last time you submitted a response. If you have used more than one, please fill in 1 questionnaire *per* facility. After submitting the first time, you will find a link to submit a new response. It will take less than 5 minutes to do so. **It would be really great if you could fill in the questionnaire by the end of the current week**.

Attached is the participant information sheet, where you can find more details about the project, and this is the link to the questionnaire: https://forms.gle/ya3QdHpaHaTWpvVV7

We are collecting data until the end of this week (26th April). If you are using any of the research facilities before Friday and you are willing to participate, you will receive this email again, please fill in new questionnaires     for     each     time     that     you     receive     this     email.

This study has been approved by the School of Education Ethics Review Panel (Application Reference Number 024728). If you have any questions about this study, please get in touch with me: a.acosta-martin@sheffield.ac.uk

**THANKS A LOT** for considering your participation again! It is really important for the project and for me.

have a good short week ahead!
Adelina

## *8.4. RF's user questionnaire*

**Tell us about your use of Research Facilities**

If you have used more than one research facility from the list below, please fill in a new questionnaire for each of them. After submitting the first time, you will find a link to submit a new response.

List of Research Facilities participating in the study:

- Biomolecular NMR Facility (MBB)
- Electron Microscopy Unit (BMS)
- Electron Microscopy Unit (MBB)
- chemMS - Mass Spectrometry Centre (CHM)
- Metabolomics - Mass Spectrometry Centre  (APS)
- Proteomics - Mass Spectrometry Centre (BMS)
- Spectroscopy & Chromatography (CHM)
- Surface Analysis Centre (CHM)
- X-Ray Crystallography  (MBB)

- X-ray Crystallography  (CHM)

*Required

## Your background

1. Select your institution *

- University of Sheffiled
- Other University
- Industry

2. Select your department *

- Animal & Plant Sciences
- Biomedical Science
- Chemistry
- Molecular Biology & Biotechnology
- Medical School
- Chemical & Biological Engineering
- Other:

## 3. Select your status *

- Undergraduate student
- Master's student
- PhD student
- Academic staff
- Postdoctoral staff
- Professional staff
- Other:

## Your interaction with research facilities

If you have used more than one research facility from the list at the top of the questionnaire, please fill in a new questionnaire for each of them. After submitting the first time, you will find a link to submit a new response.

## 4. How important is the use of this research facility for your project? *

- Not important, I could carry on with my project without using this research facility
- Somehow important, using this research facility adds value to my project but it's not essential
- Very important, I could not carry on with my project without using this research facility

## 5. How important is the support of research facility's staff for you? *

- Not important, I already knew how to run the analyses and interpret my data
- Somehow important, they are quite helpful when things go wrong
- Very important, they provide essential support and guidance through the process

## 6. Regarding your most recent use of the research facility, select all that apply from the following: *

- I've received support with the design of the experiment that I will run in the research facility
- I've been taught the theory that helps me using the research facility for my project
- I've been trained in the use of instrumentation in the research facility
- I've received support with the interpretation of results generated in the research facility
- None of the above

**7. How beneficial is the use of this research facility for your professional future? ***

- Not beneficial, I haven't learnt anything new or useful that I could add to my CV
- Somehow beneficial, I have reinforced research/technical skills that I already have and that could help me in a future role
- Very beneficial, I have learnt a lot of useful research/technical skills that I can develop in future positions

## 8.5. Consent Form – Research Facility's Staff

*Valuing the contribution of research facilities to teaching and their role in the post-graduate curriculum.*

### Consent Form – Research Facility's Staff

| Please tick the appropriate boxes | Yes | No |
|---|---|---|
| **Taking Part in the Project** | | |
| I have read and understood the project information sheet dated 18-02-2019 or the project has been fully explained to me. (If you will answer No to this question please do not proceed with this consent form until you are fully aware of what your participation in the project will mean.) | ☐ | ☐ |
| I have been given the opportunity to ask questions about the project. | ☐ | ☐ |
| I agree to take part in the project. I understand that taking part in the project will include fill in a survey with information about the teaching-related activities occurring in your research facility on a weekly basis and during 6 consecutive weeks. | ☐ | ☐ |
| I understand that my taking part is voluntary and that I can withdraw from the study at any time; I do not have to give any reasons for why I no longer want to take part and there will be no adverse consequences if I choose to withdraw. | ☐ | ☐ |
| **How my information will be used during and after the project** | | |
| I understand my personal details such as name, phone number, address and email address etc. will not be revealed to people outside the project. | ☐ | ☐ |
| I understand and agree that my words may be quoted in publications, reports, web pages, and other research outputs. I understand that I will not be named in these outputs unless I specifically request this. | ☐ | ☐ |
| I understand and agree that other authorised researchers will have access to this data only if they agree to preserve the confidentiality of the information as requested in this form. | ☐ | ☐ |
| I understand and agree that other authorised researchers may use my data in publications, reports, web pages, and other research outputs, only if they agree to preserve the confidentiality of the information as requested in this form. | ☐ | ☐ |
| I give permission for the survey data that I provide to be deposited in a data repository so it can be used for future research and learning | ☐ | ☐ |
| **So that the information you provide can be used legally by the researchers** | | |
| I agree to assign the copyright I hold in any materials generated as part of this project to The University of Sheffield. | ☐ | ☐ |

Name of participant [printed]          Signature          Date


Name of Researcher [printed]          Signature          Date


**Project contact details for further information:**

Lead researcher: Adelina E Acosta Martin on a.acosta-martin@sheffield.ac.uk or 0114 22 24676

MEd programme director: Tim Herrick on t.herrick@sheffield.ac.uk or 0114 22 28109.

## 8.6. Participant Information Sheet – Research Facility's Staff

### 1. Research Project Title

*"Valuing the contribution of research facilities to teaching and their role in the post-graduate curriculum."*

Research project for EDU6990: Dissertation, a module on the MEd in Teaching and Learning in Higher Education at the University of Sheffield.

### 2. Invitation paragraph

You are being invited to take part in a research project run by Adelina E Acosta Martin (a.acosta-martin@sheffield.ac.uk), a participant on the Masters in Teaching and Learning in Higher Education. Before you decide whether or not to participate, it is important for you to understand what the project is trying to do, and what your participation will involve.  Please take time to read the following information carefully and discuss it with others if you wish.  Please ask me if there is anything that is not clear, or if you would like more information. You are also welcome at any time to contact the MEd programme director, Tim Herrick, on t.herrick@sheffield.ac.uk.

### 3. What is the project's purpose?

In the context of this project, research facilities are laboratory spaces where bespoke analytical instrumentation or resources are available to researchers and postgraduate students, so they can use them for their research projects or instead, they can ask research facility staff to run the analysis for them. There is an important amount of teaching-related activities that are carried out as part of the interaction of research facilities' staff with researchers and students. The project aims at assessing what is the teaching contribution of research facilities in the Faculty of Science in order to enhance their value as active educational environments.

The immediate outcome will be a section of a dissertation created as part of the assessment for the module named above. The outcome of this study will also have potential for publication as an Educational Research Paper in a conference or a journal.

The intended end date of the project is the end of August 2019, which corresponds to the deadline for the assessment submission.

### 4. Why have I been chosen?

You have been chosen because you are a member of staff working in the Faculty of Science research facilities involved in the study.

### 5. Do I have to take part?

Participation is entirely voluntary. If you do decide to take part you can still withdraw at any time* without any consequences.  You do not need to give a reason. If you wish to withdraw from the research, please contact Adelina E. Acosta-Martin on a.acosta-martin@sheffield.ac.uk.

### 6. What will happen to me if I take part? What do I have to do?

If you decide to take part in this study, your participation will be completely anonymous, as no personal data will be recorded. By doing this, I am trying to encourage participants to be as honest as possible in order to collect data that truthfully represents the reality.

On a weekly basis and during 6 consecutive weeks, you will need to fill in a survey with information about the teaching-related activities occurring in your research facility.

### 7.    What are the possible disadvantages and risks of taking part?

There are no risks of taking part of the study. The only disadvantage might be the time that you will spend filling in the weekly survey.

### 8.    What are the possible benefits of taking part?

By participating in this study, you will be greatly contributing to a better understanding of the role of research facilities in teaching and training, particularly in post-graduate higher education. Quite possibly, the findings of the study will help to recognise the value of research facilities in the Faculty of Sciences as teaching environments and the important work that is made by research facilities' staff in this regard. In the longer term, both parts involved, research facilities' structures and users (students and staff), will benefit from this study and it might help improve the strategic vision and place of research facilities in a larger context.

### 9.    Will my taking part in this project be kept confidential?

Personal data will not be collected in the survey that you will need to fill in. All the information that we collect about you during the course of the research will be kept strictly confidential and will only be accessible to members of the research team. You will not be able to be identified in any reports or publications unless you have given your explicit consent for this.

### 10.    What is the legal basis for processing my personal data?

This data will be stored and processed in the United Kingdom. Therefore, according to data protection legislation, we are required to inform you that the legal basis we are applying in order to process your personal data is that 'processing is necessary for the performance of a task carried out in the public interest' (Article 6(1)(e)). Further information can be found in the University's Privacy Notice: https://www.sheffield.ac.uk/govern/data-protection/privacy/general.

### 11.    What will happen to the data collected, and the results of the research project?

Data collected in an anonymous way will be electronically and securely stored according to the University of Sheffield data management guidelines. After data analysis, findings from the research will be included in an assessed dissertation submitted as part of my work on the Masters in Teaching and Learning in Higher Education. If you are interested in these results, you can contact me directly: Adelina E Acosta Martin on a.acosta-martin@sheffield.ac.uk or 0114 22 24676, and I will be happy to share them with you. I would like the project to have an impact as positive and wider as possible, so that future uses of the research data and findings might include dissemination within the University of Sheffield and publication in educational research journals.

### 12.    Who is organising and funding the research?

The research is being organised as part of a taught programme in the School of Education, University of Sheffield.  There is no funding from external sources.

13. **Who is the Data Controller?**

The University of Sheffield will act as the data controller for this study. This means that The University is responsible for looking after your information and using it properly.

14. **Who has ethically reviewed the project?**

This project has been ethically approved via The School of Education's ethics review procedure.  The University's Research Ethics Committee monitors the application and delivery of the University's Ethics Review Procedure across the University.

15. **What if something goes wrong and I wish to complain about the research?**

If you're not happy in the project, please contact me directly: Adelina E Acosta Martin on a.acosta-martin@sheffield.ac.uk or 0114 22 24676. If this does not resolve your query, please contact the programme director, Tim Herrick.  He can be reached on t.herrick@sheffield.ac.uk, and 0114 22 28109. Finally, if you are not satisfied with this response, you can contact Dr David Hyatt, chair of the School of Education Ethics Review committee.

If you are not happy about how your personal data has been handled, information about how to raise a complaint can be found in the University's Privacy Notice: https://www.sheffield.ac.uk/govern/data-protection/privacy/general.

16. **Contact for further information**

For further information, please contact Adelina E Acosta Martin on a.acosta-martin@sheffield.ac.uk or 0114 22 24676 or Tim Herrick on t.herrick@sheffield.ac.uk, and 0114 22 28109.

17. **What's next?**

If you decide to participate you will be given a consent form that you will need to sign and keep a copy. Please keep also this information sheet for future references and questions.


Version of 18-02-2019.


# Thank you for your help with this research!

## 8.7. Ethics approval letter

Adelina Elena Acosta Martin
Registration number: 170216609
School of Education
Programme: EDUT017: Teaching and Learning in Higher Education MEd

Dear Adelina Elena

**PROJECT TITLE:** Valuing the contribution of research facilities to teaching and their role in the post-graduate curriculum.
**APPLICATION:** Reference Number 024728

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 22/02/2019 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 024728 (dated 21/02/2019).
- Participant information sheet 1056538 version 1 (21/02/2019).
- Participant information sheet 1056537 version 1 (21/02/2019).
- Participant consent form 1056314 version 1 (18/02/2019).

If during the course of the project you need to deviate significantly from the above-approved documentation please inform me since written approval will be required.

Yours sincerely


David Hyatt
Ethics Administrator
School of Education