



UCD Students' Awareness and Experiences of Research in their Undergraduate Programmes



UCD Fellowships in Teaching and
Academic Development 2014-16

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Introduction



The research theme selected for the 2014-16 Fellowship was the development of effective teaching-research linkages. The relationship between the research and teaching functions is a focus of great interest because it is central to conceptions of the role of a university. The origin of the modern view of universities is often traced to Wilhelm von Humboldt, founder of the University of Berlin in 1810, who believed that teaching and research should be combined in the activities of university staff, though, in his view, research was secondary to the teaching role (Zupanc, 2012). The priorities attached to research and teaching have been reversed in the two centuries since von Humboldt's education reforms, and research-intensive universities now dominate the landscape of Higher Education (HE).

Although research-oriented universities have achieved a dominant position, the 'added value' of educating undergraduates in research-intensive environments, which are very costly, is an important issue. It is claimed that educating students in such an environment improves disciplinary learning and inculcates discipline-specific research skills, and a broader set of generic skills, that are key to employability, and to the ability to adapt to complexity and rapid change, in modern knowledge-based economies. Another pressure arises from the development of a highly competitive global market for education, which is marked by the growing influence of international league tables of universities. In that context, the benefits of providing an education in a research-intensive institution may be seen as an important selling point to attract students, staff, and funding. Tensions remain, of course, and concern has been expressed about whether the research is now too highly valued relative to teaching, with consequences such as the 'unbundling' of these functions in the higher education sector generally, and within research-intensive universities (de Jonghe, 2005; Hajdarpasic et al., 2015).

UCD is a large research-intensive university, situated in an open, knowledge-based economy, but with a global outlook, and is subject to the all pressures described above. Its response is outlined in the UCD Strategy 2015-2020. A key part of that strategy is a commitment to student-focused, 'research-led' education in a community based on strong research-intensive disciplines. A central plank of the plan for implementation of this strategy is a curriculum review and enhancement process, which is currently underway. However, what exactly is meant by the term 'research-led education', and how that can be realised in an institution that includes the full spectrum of disciplines, in a time of tightly constrained resources, is not entirely clear. It is hoped that the current research project will provide important evidence to inform UCD policy, and to guide curriculum designers, as UCD embarks on the major revision of its taught programmes.

2 Context

The relationship between research and teaching in universities has long been a source of contention, and has given rise to a voluminous literature. Two strands are of particular relevance to the Fellowship project, (i) the 'research-teaching nexus', and (ii) enhancing engagement and learning by integration of research into the undergraduate curriculum.

2.1 The research-teaching nexus

The phrase 'research-teaching nexus' is used to describe the complex relationship of synergies and tensions that exists between research and teaching activities, at the level of individual staff, at school level, and at institutional level (Malcolm, 2014). By the 1960s, the dominant paradigm was that research activity and teaching are mutually reinforcing, but evidence for that belief was lacking, throwing into question the justification for the great cost of educating students in research-intensive universities (Mägi and Beerkens, 2015). Much effort was expended in attempts to establish links between the research activity of academic staff and the quality of their teaching (Hattie and Marsh, 1996). However, it is now widely accepted that such correlations are weak, and that the research aimed at discovering them is fraught with methodological difficulties (Brew and Boud, 1995; Jenkins, 2004; Zaman, 2004; Verburch et al., 2007; Malcolm, 2014). In the last two decades the emphasis has shifted towards attempts to understand the details of the nexus. The views of senior administrators, academic staff, and students have been probed, using both quantitative and qualitative methods, and many details of the nexus have been revealed (Trowler and Wareham, 2008; Brew, 2012; Malcolm, 2014; Duff and Marriott, 2016; Harland, 2016).

Studies on the perceptions of students are of particular relevance to the work of this team. Beginning with the ground-breaking work of Neumann in Macquarie University (Neumann, 1994) numerous studies of student perceptions from higher education institutes around the world (e.g. Jenkins et al., 1998; Zamorski, 2002a, 2002b), have provided detailed insights into undergraduates' awareness and experiences of research, their views on the value of those experiences, and their perceptions of the strengths and weaknesses of the curricula. The results show that students value the opportunity to work with active researchers and find it to be a generally positive experience that promotes engagement and self-efficacy, and enhances a wide range of disciplinary and transferable skills. Students recognise the value of actually carrying out research, both in helping them to decide what careers to pursue and in preparing them for those careers. However, they also report some negative experiences, many of which relate to inadequate preparation or mentoring. Some feel quite peripheral to the research enterprise in their university and many express a desire for greater inclusion, whereas others would prefer not to have research experiences because they do not see any relevance to their personal career goals.

2.2 Integration of research into the undergraduate curriculum

Prompted by the recommendations of the Boyer Commission on Educating Undergraduates in the Research University (Boyer Commission, 1999), and with the growing awareness of the benefits of incorporating research experiences into undergraduate curricula, there was an explosion of interest in this area (Katkin, 2003). Many case studies have been reported and reviews have concluded that the benefits are real and substantial (Hu et al., 2008; Lopatto, 2009; Sadler et al., 2009; Craney et al., 2011; Earley, 2014; Zimbardi & Myatt, 2014; Linn et al., 2015), but that care must be taken to avoid potential pitfalls (Gresty et al., 2014).

The emerging view is that the sought after synergy of research and teaching can be achieved in carefully designed curricula in which students' skills and awareness of research are gradually built up, in the context of their learning in their disciplines. Compendia of good examples (Jenkins, Healey & Zetter, 2007; Healey & Jenkins, 2009), and guidelines for design and implementation of 'research-led' curricula, across a wide range of disciplines and contexts, are available (Hensel, 2012; Brew, 2013; Healey et al., 2014; National Academies of Sciences; Engineering; and Medicine, 2017).

Although there is now a very large corpus of research on aspects of the research-teaching nexus, significant gaps remain. An obvious gap from the UCD perspective is that there is no study of the experiences of students in an Irish institution. A study in an Irish setting would illuminate the impact of the peculiar features of the Irish educational system, as well as providing a basis for local action. Even though there are approximately 20 studies of the student experience of research in the curriculum, many of those studies have a narrow focus or involve small numbers of students and/or disciplines. It was of interest to conduct a wide ranging study, involving a substantial number of students from a range of disciplines that was representative of the variety available in UCD. Significant differences between the experiences of students in different disciplines have been reported, but understanding of these differences is quite incomplete.



3 Aims and Methods



The primary aim of this study was to examine undergraduate students' awareness of, and exposure to, research in their discipline/programme, and their perceptions of how studying at a research-intensive university impacts their learning.

The study attempted to address the following research questions:

1. To what extent are undergraduate students aware of research conducted by staff in their chosen discipline/programme, and in their programme/discipline more generally, and how has this awareness developed?
2. In what ways, if any, do undergraduate students in UCD perceive that research has been linked to their learning and/or teaching experiences in the curriculum or in the wider university?
3. In what ways, if any, do undergraduate students in UCD perceive that their skills and attitudes have been impacted by teaching and learning at a research-intensive university?
4. In what ways, if any, do undergraduate students' awareness and experiences of research, and perceptions of how it has impacted their learning, vary according to their stage of study and discipline/programme?
5. What do undergraduate students perceive as examples of good practice in terms of research-teaching linkages? And what are undergraduate students' perceptions of specific research-teaching linkages as identified by a member of staff or an examination of the curriculum?

Our aim was to obtain a sample of undergraduate students' perspectives from across the university. We chose a focus group methodology to collect the data and in total conducted seven focus groups in March and April of 2015 with final year students, each one consisting of undergraduates from a programme/discipline from one of the seven UCD colleges. Three focus groups of first year students – one each from Arts, Engineering, and Science – were also conducted. Participants for focus groups were mainly recruited in lectures by administering a short survey to the target group of students at the end of class. The focus groups were usually conducted immediately afterwards with lunch provided. The short survey contained questions on research awareness and experiences, and collected demographic data about the students (Appendix 1). A sample Focus Group Schedule is available in Appendix 2. A summary of the number of students involved in the study, and their disciplines/programmes, is shown in Table 1 (overleaf).

The focus group audios were transcribed and team members familiarized themselves with the final year focus groups by listening to the audio recordings and reading the transcripts several times. On completion of this, the team members worked together to code one of the focus group transcripts. A research assistant then applied these codes to the transcript using NVivo, and independently coded a second transcript using the coding scheme. The team then met to examine the second coded transcript and this resulted in a refinement of the codes. The research assistant coded the remaining five final year focus groups using the coding scheme developed. On completion of this task each of these five final year transcripts was double-coded by a member of the team. By the end of this process there was strong agreement among team members about the coding scheme developed. Findings are discussed below.

Table 1: Summary of data collected

College	Discipline (Final Year)	Prog. Length	N° of Surveys	N° in Focus Group
Health Sciences	Physiology	4 years	9	9
Science	Chemistry	4 years	34	9
Engineering and Architecture	Chemical Engineering	4 years	32	8
Health Sciences	Physiotherapy	4 years	57	9
Business and Law	Law	4 years	94	8
Human Sciences, Arts, and Celtic Studies	Arts	3 years	8	8
Agriculture, Food Science, and Veterinary Medicine	Agriculture and Food Science	4 years	41	8
	Geography		38	
	English		19	
	Social Science/Sociology		21	
College	Discipline (First Year)			
Science	Science – Chemistry	4 years	70	8
Human Sciences	Arts – Geography	3 years	12	12
Engineering and Architecture	Engineering	4 years	62	10
			497	89

The survey data was inputted to Excel and descriptive statistics produced. The open-ended question data were coded and descriptive statistics produced regarding the students' awareness and experiences of research-teaching linkages. Comparisons were made between first (n = 157) and final year (n = 343) students' awareness and experiences in UCD, and further analysis of potential differences across disciplines/programmes carried out. Of the first year students surveyed 45% were female and 47% were male, and they were predominantly Irish (80%) and recent school leavers (93%). Of the final year students surveyed 57% were female and 39% were male, and they were predominantly Irish (90%) and recent school leavers (87%).

On analysing the seven final year focus groups, it was noted that the BA focus group was somewhat of an outlier. The reason for this is that it lacked the homogeneity of student cohort that was present in the other six final year groups. We attempted to conduct a focus group with final year BA in English students, with BA in Geography students, and BA in Social Science/Sociology students. All had to be abandoned due to poor participation rates. In the end a focus group with eight final year BA students was included, however they represented a range of disciplines. The following were mentioned during the discussion: Economics, English, English and Film, Geography, History, Irish, Mathematics, Music, and Sociology. At most two students in the group represented each of these disciplines therefore we are reluctant to draw any major conclusions from what was said. In summary, it is not possible to give a detailed programmatic overview for the final year BA group in the same way that is possible for the other six final year focus groups.

The results of the analysis of the survey and focus group data are presented below in relation to key themes of student awareness of research, the quality of students' research experiences, and the value of research-teaching linkages from the students' perspective. The value of these research experiences and the Capstone Experience (completion of a Stage 4 research project or a Stage 3 and/or Stage 4 work placement equivalent to 10 ECT credits) in particular will be discussed in more detail below.



4 Awareness of Research



Students' awareness of research in UCD was probed by seven items in the survey (Appendix 1) and by three sections of the focus group schedule (Appendix 2). The survey results are presented first and the deeper insights obtained from the focus groups are then discussed.

The survey data indicate that students, including those in Stage 1, have a high awareness of the fact that UCD staff are active researchers. Comparisons with the data from other institutions is possible because many of the questions in the survey instrument were based on the questionnaire developed by Healey et al. (2010) that was also used in other studies. Some of the data for UCD, and for final year students in the University of Otago (Spronken-Smith et al., 2014), unnamed research-intensive universities in the UK and Canada (Turner et al., 2008), and Macquarie University (Hajdarasic et al., 2015), are shown in Table 2. These data should be treated with caution because the UCD sample is not statistically representative (the same is true of most of the samples from the other institutions), but the awareness reported by final stage students in UCD appears to be similar to that of students in the research-intensive universities in Canada and the UK.

Table 2: Awareness (%) of research in UCD students and in students of research-intensive universities from other countries

Undergraduate awareness of:	Otago Final yr (n = 306)	Can RI Final yr (n = 307)	UK RI Final yr (n = 45)	Macquarie Final yr (n = 200)	UCD St. 3/4 (n = 343)	UCD St. 1 (n = 157)
Research seminars/conferences	78	75	77	65	63	46
Research centres/themes or groups	27	72	30	62	73	85
Areas with national and/or international research reputations	32	60	32	48	58	52
Books, journals & other research outputs produced by staff	68	68	86	83.5	88	50
Research posters/exhibitions/displays		63	64	68	70	75
Notice boards advertising research/postgrad opportunities		59	77	81.5	76	59

This awareness developed through the research experiences in their programme and interactions with staff. A selection of the survey data on students' experiences of research is presented in Table 3, which also includes some data from the international studies mentioned above. Again, it is clear that UCD students have a high level of research experiences by international standards. A large majority of final stage students had experience of lecturers discussing research and research methods, and it is encouraging that the same was true of most Stage 1 students (entries 1 & 2). Entries 3 to 8 show that most students reported that they learned research skills and perceived that they have had an opportunity to put those skills into practice in their programmes, and, again, this seems to be true even in Stage 1. However, these high percentages should be treated with caution because it is not clear how students interpreted the term "research". Analysis of the focus group results (see below) does not support the view that such high proportions of students engage in research in the sense of contributing to new knowledge or scholarship. It is likely that some students interpreted the term in the familiar sense of having to discover information for themselves. When it comes to acting as research assistants and attending performances, seminars, or conferences (entries 9-12), only a small minority of students reported that they had such experiences, and the percentage of Stage 1 students reporting such experiences was tiny.

Table 3: Experience (% answering yes) of research in UCD students and in students of research-intensive universities from other countries

Entry	Undergraduate experience of:	Otago Final yr (n = 306)	Can RI Final yr (n = 307)	UK RI Final yr (n = 45)	UCD St. 3/4 (n = 343)	UCD St. 1 (n = 157)
1	Listened to a lecturer talk about research (his or her own, or other)	77	85	84	90	84
2	Listened to a lecturer talk about how research is conducted				71	54
3	Undertaken research for a project	54	43	55	84	85
4	Undertaken research for an essay/assignment				95	88
5	Formally presented your own ideas/research				75	59
6	Read research reports or journal articles				97	80
7	Read a research paper, report or book written by a member of UCD staff	66	60	64	84	22
8	Developed research skills	62	27	32	89	77
9	Acted as a research assistant within UCD	11	17	0	15	3
10	Attended an artistic performance or exhibition linked to your subject area(s)				18	8
11	Attended a research seminar				25	4
12	Attended a research conference				9	1

Turning now to the results from the focus groups, across all ten groups students demonstrated that they were very aware that research is conducted in UCD. It is important to note that it is clear from the focus group discussions that the participants were, overwhelmingly, using the term 'research' in the sense of 'contributions to knowledge'. Their awareness of research seems to have developed in three major ways. Firstly, via the physical environment and the media, e.g. seeing research laboratories and institutes on campus, seeing posters about research and requests for participants for research studies in buildings, reading the UCD website, and seeing/hearing UCD research highlighted in the media and social media. Some students cited having an awareness of research in UCD even as secondary school students. Secondly, as a consequence of research experiences embedded in the curriculum, for example, lecturers speaking informally about their own, or a colleague's research, in lectures, research methodology modules, learning about other's research in modules, and Capstone Experiences (research projects and/or substantial work placements). Thirdly, undergraduate students' awareness of research in their discipline seems to develop as a result of informal interactions with the people around them and the shared spaces that they inhabit. Examples include informal discussions with lecturers about research, interactions with undergraduates in later stages, discussions with postgraduate students and/or postdoctoral researchers in laboratories or tutorials, and student society events. Invitations to research seminars or to participate in research studies, and/or the building in which the student is based, particularly in later years, also contributed to an awareness of research being conducted in their discipline.

4.1 Awareness arising from the environment

Some focus group participants remarked on the fact that they became aware that UCD was a research-intensive university while they were still at secondary school, from the descriptions of staff research on the website and from recruitment events, and that this was a significant factor in their decision to come to UCD. Participants were very much aware of the existence of research facilities in UCD though they are vague on the details, especially in Stage 1.

I have seen at the top floor of the science building, there is that whole earth research whole floor basically, and there is just a sign on the door and there is a hallway and just researchers about the place. (Stage 1 Engineering)

Participants reported that in the early stages of their studies they often viewed research facilities as mysterious and inaccessible.

I think that most of the research posters like you were saying, are in this building, and from first to second year we don't really have a lot of access to this building, and we just thought it was just for the postgraduate students. So we would kind of be afraid to kind of come in and walk by the posters. (Stage 4 Chemistry)

Awareness grows as the years progress, so by their final year, students have a much clearer knowledge of research centres and laboratories, especially if they have participated in a final year project or other Capstone Experience.

And we went on class trips out there (Lyons Farm), you know, from various modules. And health and safety trips and what not. So we kind of see a little bit of what is going there and the facilities that they have and how they conduct some of the research stuff. That kind of adds to your awareness of what is going on out there. (Stage 4 Agriculture and Food Science)

Engaging in a research project means that students may have access to research laboratories and facilities that they otherwise would not enter. Access to state-of-the-art research facilities is, of course, one of the principal distinguishing features of studying at a research-intensive university. In addition, some of these laboratories and rooms showcase research that has been published.

As well when we started doing our own research studies in the lab in the physio department, there are posters up of research studies that have been done. It is only this year that we have really been in that room to see that... from doing our own research studies. (Stage 4 Physiotherapy)

There were many references to notices regarding research, and posters and papers posted in the buildings, especially outside research laboratories and staff offices. However, it is clear that seeing posters etc. commonly leads to no more than a superficial general awareness of research activity. This may be due to the fact that such posters are prepared for display at research conferences so they are written at a level that is very difficult for undergraduates to understand. Perhaps efforts could be made to prepare posters on staff research interests that are aimed specifically at undergraduate students. Students from Chemical and Bioprocess Engineering mentioned the practice of mounting posters prepared by Stage 2 students in the lecture theatre used by the students in other stages.

Yeah, we got a poster and everyone in the group printed the poster and the posters actually go up in one three zero; which is one of the classrooms that is used a lot for lectures and studying for chemical engineers. So then, you know, for that semester or that six or twelve months, all the other years would get to see the second years' posters... That is quite good actually. (Stage 4 Chemical and Bioprocess Engineering)

Also, notices regarding internship or research opportunities that are targeted at undergraduate students attract attention and highlight current research. There are notice boards specifically for Stage 3 and Stage 4 Agriculture students, and the final stage students are kept informed of research opportunities and seminars by email.

Many students mentioned that they had noticed stories about research achievements of staff on the UCD website and in other media (newspapers, radio, social media etc.). These stories were more impactful than posters, possibly because they featured particularly noteworthy achievements and were featured in prestigious media channels.

I think even sometimes on the news and that, often you see UCD being involved... like there might be news stories about research that is being done in UCD. So that kind of is showing how much research is going on at a broader level to the whole of Ireland, but not people who are just in UCD. So it obviously shows that there is high tech things going on if it is making the news. (Stage 4 Physiotherapy)

4.2 Awareness arising from research-related activities in curricula

Not surprisingly, the curricula of their programmes of study can have a major impact on students' awareness of research activity in UCD. In early stages, exposure to research typically involves activities such as reading assignments from lecturers' publications and mention of staff research interests in lectures. Though the

research is often described in a relatively superficial way in early stages, and students are often aware that they do not yet have the depth of knowledge to understand research results in detail, hearing and reading about staff research can have a very positive impact.

*I remember my very first lecture was [module/course name] by Professor [staff member's name] and... one of the very first things she mentioned was that she does her own research... and personally I feel that that... it is kind of like a hands on example of not only the stuff that we are learning but also how it is being applied immediately and how our researchers don't just study theory but they actually practice what they are teaching us, which is quite interesting as well as it gives us something to look forward to and something interesting to know about our lecturers.
(Stage 1 Science)*

Although there were numerous references to staff referring to their own research in lectures in every focus group, there were some indications that the practice of adding some information on individual research interests is more common in some disciplines than in others.

*...like you know these people are doing the research but they don't seem to bring it to the actual lecture halls or tutorials as much. I don't know, it is just my experience anyway that you don't really see it as much. Like research from UCD coming into the classroom, so to speak.
(Stage 1 Arts)*

Referring to UCD staff research interests and results seems to be a very effective, and engaging, method of raising awareness and is relatively easy to do. It is one of the simplest ways of highlighting the added value of studying at a research-intensive institution. Related studies in overseas HE institutions revealed that students were concerned that the curriculum might be distorted if staff brought their research interests into their teaching, but that opinion was not voiced in the focus groups, and the danger seems small provided there is reasonable oversight within programmes.

The practice of assigning staff research papers in assignments, essays, and projects is common in later stages, sometimes forming part of research skills modules that include information literacy skills, such as searching for and interpreting research papers. Participants in several focus group noted that in later stages more emphasis was placed on the importance of providing evidence, with supporting references, to support arguments.

Another frequent thread in the focus groups was the prevalence in late stages of advanced modules in which lecturers taught topics in which they are active researchers, allowing them to discuss their own research in more detail.

*I noticed... that as the modules got more specialised... that most of the lecturers actually did do research or were currently doing research in that specific topic. So I suppose it kind of makes it more interesting if you know that they are currently studying it and the information that you are getting, that they are giving you, isn't just something they have read or they have studied themselves. They are actually actively trying to discover more about it. So it makes it more interesting I think to listen to them in lectures and I think you engage more with the subject.
(Stage 3 Arts)*

One variation on that theme is a final stage module in Chemical Engineering in which current PhD students give seminars on their research. That module seemed to strike a chord with the students, as did a related module component in Geography.

Yeah, that seminar we had where the PhD students gave talks each week was really great to find out like what was going on and it would probably benefit like the lower years um... just like "This is the kind of research that you can do in chemical engineering. Like this is the huge variety of things that they do". (Stage 4 Chemical and Bioprocess Engineering)

In Geography we have students doing their PhDs come in as guest lecturers. So we kind of see their take on it... Yeah, it is good to see their perspective on it like and I suppose it is kind of easier to understand them from a kind of younger point of view. (Stage 3 Arts)

As would be expected, the opportunity to be involved in research projects has a huge impact on students' awareness and understanding of research in their disciplines in UCD. In some disciplines, e.g. Physiotherapy and some of the Social Sciences, this involvement often begins when students volunteer to act as participants in research projects carried out by staff, research students, or advanced undergraduate students. A significant minority get an opportunity to carry out research internships, and a substantial proportion have direct experience of research in professional placements and/or in capstone research projects. These experiences are hugely influential and their unique features will be highlighted in a later section.

Obviously, engaging in a research project brings students into closer contact with lecturing staff, and usually one-to-one or small-group supervision from an academic. However just knowing that they will have to do a research project in Stage 4 meant that even as early as Stage 2, some students were paying attention to lecturers' research areas.

And when we were in second year as well, we knew we would be going into a research project. So it was always in the back of everyone's mind that, you know, you had to look at lecturers and see what they were doing to, you know, I probably knew from first year that in fourth year I would be in a lab. (Stage 4 Physiology)

Research projects build general awareness because students often check the research interests of many staff members before choosing an internship or project and attend presentations by their classmates, and they give students a detailed insight into the research being carried out in the groups in which they are working. Also, work and clinical placements heighten awareness of the importance of research in professional practice. Moreover, employers and co-workers often refer to the contributions of UCD staff, thus increasing awareness of research activity in UCD and of its significance in the 'real world'.

Just being out in hospitals on placement, they kind of talk about some of the physios and what research they have been doing in UCD, but you are not really aware of it. So they kind of opened up my mind to what is actually going on in UCD that I don't know about. (Stage 4 Physiotherapy)

4.3 Awareness arising from informal contacts

The discussions in the focus groups revealed the importance of some methods of building awareness of research that were not captured in the survey. Perhaps the most important of these are informal contacts between students and other members of their Schools: the staff, the postgraduate and postdoctoral researchers, and the students in later stages of the same programme.

Like they [staff member's name] are always happy to tell you about their research and show you their posters and you speak with their post graduates, and I think that is where I first got my big taste of like... I know I wasn't doing research but where I started to learn what research actually goes on. (Stage 4 Chemistry)

As mentioned in that excerpt, discussions with postgraduate students, typically in laboratory classes and in tutorials, are a very common way for students to learn about research activities in their Schools.

...in tutorials and listening to the experiences of the tutor and because most tutors are PhD or Masters students, so they are doing their own research and listening to them and their experiences. Like they would use that as examples in their tutorials and I think that... for me personally that is how I understand how research has been done in arts subjects. (Stage 1 Arts)

...it was the postgraduates and you are spending hours with these people. You start asking questions and they tell you their research and that just leads on. Every week you build upon that. (Stage 4 Chemistry)

There were some references to learning about research from conversations with students in later stages and from events organised by student societies. The first excerpt below is also interesting in that it mentions the role of shared learning spaces in facilitating interactions between students from different stages.

You would be just asking the older years, you know, as we share the same classroom. "So are you stressed at the moment? What are you working on?", and it just comes up that um... you know, someone would be working on their laptop, typing away on MatLab and it would be like "What are you doing?" and they would say research projects. So you would become aware of what the older years are doing. (Stage 4 Chemical and Bioprocess Engineering)

Another possibility to get closer to research is the societies in UCD. Like there are lots and lots of guests coming again in Archaeology, and introducing their latest results of their own research... So again it is a different kind of exposure to the recent research in their area. (Stage 1 Arts)

The many references in the focus groups to interactions with fellow undergraduates, and with postgraduate students, speak to the importance of the broader community within which students work and learn. There may be opportunities to harness that community more effectively in building stronger research-teaching linkages, e.g. by making postgrads more aware of the issues as part of their training, or by supporting student societies more strongly.

This study revealed a high awareness of research among undergraduate students in UCD, an awareness which is on a par with that reported by research-intensive universities internationally. Nonetheless, the student perspective indicates that more could be done to systematically build awareness, particularly in the early stages of programmes. Students appeared eager to learn more about the research activities going on around them and enjoy the feeling of being part of an institution that is home to researchers with national and international reputations.

5 Quality of Research Experiences



Students' experiences of research in UCD were probed by 18 questions in the survey (Appendix 1) and by two sections (experiences and impact) of the focus group schedule (Appendix 2). As described in the previous section, and detailed in Table 3, the survey data indicate that UCD students have a large number of research experiences in their programmes by international standards. It is not possible to compile a comprehensive list of the types of experiences that UCD students get from the focus group data because there were too few groups and the discussions were often dominated by just a few modules, often research projects and work placements. However, the combined survey and focus group results show that research is brought into the curriculum in many different ways, including use of staff research in lectures and case studies, numerous types of inquiry-based learning and problem-based learning projects and modules, research skills modules, and Capstone Experiences such as research projects and work placements. Rather than cataloguing these methods of embedding research in teaching, this section will focus on the 'quality' of those methods, by which we mean how effective they were from the student perspective.

Students reported both positive and negative research experiences. The very positive reaction of students to instances of lecturers bringing their own research into their teaching was described in the previous section on awareness. The numerous positive comments relating to opportunities for hands-on learning, independent learning, skills development, and opportunities to link teaching to the workplace will be detailed in the section on student perspectives on the value of research experiences. This section focuses on student perceptions of the factors that contributed to positive, or negative, research experiences. Among the factors identified by students, the provision of adequate preparation, the importance of teaching research skills in appropriate contexts, and the need for good support by postgraduates and staff, came across very strongly, as well as a number of other factors relating to module design. These factors are discussed below, and examples of good teaching practice identified by students are highlighted.

5.1 Accessible, well-timed preparation for research experiences is crucial

When they enter UCD most undergraduate students have little understanding of what research involves, or how it is carried out. Because engagement with research requires learning many new skills, good preparation is important and students' experiences were mixed. Some research skills courses were viewed positively, and seemed to provide timely introductions to key skills that were presented in an engaging and supportive way.

The critical theory module that all English students have to take in second year... in that module we are taught how to engage with high concept academic essays and I still use in my own work the stuff that we learned about in that module. And I even still use the book from that module still in my essay work and stuff. (Stage 3 Arts)

However there were some negative experiences too. This varied across disciplines, with some students reporting that they felt that they had not received adequate preparation for the research or inquiry elements of their course. While comments such as those shown below may not be representative of majority opinion, they do indicate a need to review the training in key research skills in our programmes.

Whereas compared to like that other modules just like if you were just thrown a load of references with just figures on a lecture slide and no idea how to break it down. You get frustrated when you are studying and you just... you mean... say... yeah it is just hard. I know we don't want to be spoon fed either, and they say "We can't give you everything" and we completely understand that, but don't send us off on a wild goose chase where we spend forty minutes trying to get one paper, which is forty minutes lost, like you know that kind of way. (Stage 4 Physiology)

For me, I am still doing essays and they are alright, but I still feel I can't read references or research things properly. We have only the database so I don't know what to type into them or what to use or ... there are so many different ways you can look up things and someone could get a different result than you because they typed in a certain different thing. So I personally feel that the programme has kind of lacked in teaching research skills and that is what I think anyway. (Stage 4 Business and Law)

The timing of some modules can present a barrier to student learning and engagement. If sequencing is poor, skills may not be taught in time to meet the demands of the programme, or students may not understand the significance of what they are being asked to learn.

We did an elective in second year that they taught us how to rate um... using the PEDro scale; the standard of an article. And at the time it seemed kind of, I don't know, it didn't quite make sense but then the next year when we actually had to do it, then I was like "Oh that was actually really helpful". But at the time... I was like "Oh this is not really that relevant". (Stage 4 Physiotherapy)

This concern was also noted in the Stage 1 Arts focus group in relation to an Introduction to Arts Module which is no longer available to students in this discipline. While it was noted that this module contained "crucial skills" it was "spread it out over ten weeks, which meant you learnt about essay writing in week eight or constructive... or critical thinking in week six, when you really should be applying it from day one".

Many students reported that the transition from Stage 2 to Stage 3 and/or Stage 4 was particularly challenging, and not all felt that the earlier stages provided sufficient preparation for the 'jump' to research projects.

I kind of found there was a very distinct division between finishing second year and starting third year, and I know they speak of the first two years is more theoretical um... more observational on the placements you are on for the three weeks that you are on placement, but then in third year you are really thrown into the deep end; it obviously depends on the placement site that you are at, but then even once you come back into the second semester of third year, there is a higher expectation, and I think that higher expectation should be there from the start. (Stage 4 Physiotherapy)

And then in fourth year we are dumped in... really thrown in at the deep end and expected to work out how to do all these things we have never been taught. So I think there should be some degree of structure put on our lab work that is aiming us at something more than just getting us through that day and giving us credits. It wasn't helpful for me in either research or...second and third year labs basically for me I found did nothing to help me in any way once I got to fourth year. (Stage 4 Chemistry)

In summary, the student comments point to the need for a carefully sequenced, comprehensive development of the necessary research skills, within each programme, from fundamental concepts in Stage 1 to advanced skills in the late stages.

5.2 Introduction to research skills works best when there is an authentic context

A strong theme that emerged from many focus groups was that learning of research skills was improved when those skills were taught in the context of authentic research projects that allowed students to get meaningful experience of applying them.

I think something like that can be very subject dependent, because last semester in music we actually did a music and film module and we could like... we were basically told from the outset "You won't find sources because it is a very specific kind of niche" and so that in a sense kind of gave you an idea of what it would be like to go on if you were to carry on doing music and film. You would know exactly kind of how you would have to go about your research and stuff like that. So that was good because it was research incorporated in, without being "Here is a research module". (Stage 3 Arts)

In the same vein, the next quote illustrates how students can be asked to complete a literature review on a topic, but it is not until the research is required to inform practice while students are on work placement, that they develop an appreciation for research.

I found that I was looking up research and everything and I found where before that, it was just you were told: "Ok, do your literature review and use it" and you are like "Ok, I have to do this because it is for ten percent". But while on placement you actually had to go about it yourself and you found that I needed it... like you know, you need that research to even help yourself so that you don't walk around not knowing what is even going on, on your placement. You have to be up to date on everything to kind of help them improve as well... so it was really important there I found, and that is where I suppose the bigger picture came and kind of saw the importance of it all. Like where it all came together. (Stage 4 Agriculture and Food Science)

A related theme emerged where students expressed a preference for open-ended projects/assignments that allowed them to demonstrate their creativity, though that was tempered by recognition that it might be more difficult to get high grades in such cases.

In concepts in engineering, we are given a topic and we have to research it and then like write an essay about it. It was good practice researching and then we had to give a presentation about what we found out afterwards and it was good. There is not just one set answer, like you really take your own approach to it and you find your own solution and what you think is important. It is not just it is right or wrong. I think there is lots of different aspects to it and different ways to... I suppose at the end of the day you are looking for a good grade like, but it is not just one set way. (Stage 1 Engineering)

Similar positive sentiments were expressed about having opportunities for independent learning in some inquiry-based learning modules in Science.

5.3 Support from staff and postgrads greatly affects the quality of research experiences

Support from staff was highlighted as very important by students, particularly in relation to problem-based learning modules (e.g. the Principles of Scientific Enquiry module in the BSc programme) and research projects, and it was acknowledged in some focus groups that support could vary across staff members.

...like groups of three students will be placed to individual staff members. So your experience can change very dramatically between where you are placed and then some people feel like they might not have enough support and some people feel they are being watched too closely and stuff. (Stage 4 Chemical and Bioprocess Engineering)

Some students expressed disappointment in relation to the attitude of postgraduate students who were assigned to help them in their research projects. Examples of negative experiences included a perceived reluctance of postgraduate students to share lab space, and pressure to work long hours to produce results, as expressed by participants in the final year Chemical and Bioprocess Engineering and Chemistry focus groups, respectively.

The sense of identity and belonging that some groups of students felt was striking and this often increased awareness of research being carried out within their discipline, and increased the quality of research experiences. Proximity to staff and postgraduate researchers increased for some groups in Stage 3 with the commencement of laboratory-based research projects, e.g. in Physiology, Chemistry, and Chemical and Bioprocess Engineering. With increased proximity to staff and postgraduate students, students availed of opportunities to question and learn from more senior laboratory members while completing their final year project. Carrying out research projects within a research team can give students the feeling of being participants in a larger research community.

Definitely this year when we are doing our research projects, you know, you might be working on a project similar to what a PhD student and similar to what your supervisor's research is. So it kind of all ties in that there is different... you know, it is different people working on different... but towards the same goal. (Stage 4 Chemical and Bioprocess Engineering)

Having access to research facilities and specific classrooms for their group also added to the sense of belonging and enhanced the quality of some students' research experiences within UCD, e.g. final year students studying Engineering, as well as final year students in Physiology and Chemistry. Unsurprisingly, this sense of belonging can develop more strongly in smaller classes.

So I suppose the awareness deepens as your own understanding of chemical engineering increases, and as you get closer to the Professors. Like they would all know us on first name terms. So that is the advantage of a small school. (Stage 4 Chemical and Bioprocess Engineering)

In addition, for some groups, clinical placements provided opportunities to network and learn from clinical tutors, e.g. in Physiotherapy, further expanding the community to which they belonged.

5.4 Other issues can affect the quality of research experiences

In addition to the major themes discussed above, students occasionally referred to other aspects of their research experiences that had an impact on their learning. One such issue arose in relation to students being organised into teams, as is often the case in inquiry-based learning and project work. Although the students were generally supportive of working in teams, they pointed out some of the negatives too.

I thought it worked well with the groups because in the real world like you do dissertations as a group. You don't regularly undertake study as an independent person. You have four or five in a group... So I liked the groups (Stage 4 Physiotherapy)

But he also forces you into groups; which did not work so well. So what we gained from the research ourselves, we kind of lost with other people not um... like we were forced into teams with some people that weren't so interested and didn't do work, and then we had a much more thorough knowledge in some areas and like gaping holes where we should have known things in other areas... I had a very good team but I have heard some terrible stories from other people. (Stage 4 Chemistry)

Some students emphasised the importance of being given enough time to carry out their research. Research work is challenging, and it can be difficult to strike an appropriate balance between research activities and other coursework.

So in terms of having that time to collect your data and then analyse it and write it up well and even to do a number of drafts; I think that maybe having it a yearlong has been beneficial; but then doing it over a placement is quite difficult as well, because it is quite hard to focus on two things at the same time. (Stage 4 Physiotherapy)

It was difficult was well like we had the research project, we also had four modules going on at the same time. So you might have a supervisor, like say like a PhD who is on your case, you know, "I need you in here Monday to Friday I want this project to work". But you also have four lecturers pulling you in the other direction, being like "Well you can't be in lab because you have my course to study for". So there is a huge aspect of trying to balance those two. I think a lot of people would have found that a tough course. Like keep up with your research and try to keep up with the modules. So it definitely pulled you two directions. (Stage 4 Chemistry)



6 Value of Research-Teaching Linkages



Students' perceptions of the value of including research skills in their programmes were queried in two sections (impact and value) of the focus group schedule (Appendix 2). While students' experiences of research varied across disciplines, a large majority of students believed that having research experience was important and valuable in terms of the application of skills gained during research-based tasks in future careers more generally and, for some groups, the relevance of research to their specific future career. Appreciation of the value of research was most striking in groups who completed a final year research project and/or a clinical or industry-based work placement as part of their degree programme, e.g. students in their final year studying for degrees within the Schools of Agriculture and Food Science, Physiotherapy, and Engineering. This research component (Capstone Experience) was noticeably lacking from other groups in their final year, e.g. Business and Law students. This important aspect of the results is described in detail later.

The value of educating students in a research-intensive university is multi-faceted and evidence suggests that students benefit from developing a range of skills specific to their disciplines, universal competences desirable for a range of career choices, and important generic attributes such as communication skills and time management. In our study, UCD students eloquently articulated how specific research experiences were valuable (or invaluable) to them in several ways:

- by defining or supporting their career choice in research, industry, or professional vocations
- by augmenting their understanding of the important role of research in their career choice
- by instilling confidence in their abilities as graduates and improving their employability
- by providing a context for their learning, leading to greater interest and engagement
- by enhancing or developing their discipline-specific and transferable skills

6.1 Research experiences define/support career choice for students

When research opportunities are provided, there is broad agreement across most disciplines regarding the value of undergraduate research experiences in helping students to determine whether postgraduate research is right for them, or whether an alternative career choice is more appropriate. Some students commented that on entering the programme they had not considered pursuing a research career or completing a PhD, but that completing a research project had made them realise that this was something they enjoyed and was now a career option.

*I chose science because I wanted to be a teacher and now coming to the end of my Degree I want to do research. So it is just being exposed to research itself, has completely changed kind of my focus or my aims. So definitely I would say it has impacted my learning.
(Stage 4 Physiology)*

Others found that the experience of doing research revealed that it was not the right choice for them.

I think I was personally put off doing a Masters because I am not that into doing research and I don't like the process. But I had enough of an exposure to it and I had to do enough to it to 1) be able to do it, and 2) know for certain whether or not it was for me. And I think everybody who I have encountered certainly in our course, has had enough experience that they know for definite whether they like doing research. (Stage 3 Arts)

Some students were given the opportunity to experience a career in industry or professional vocations through work placements or internships. Being exposed to a research project and/or a work placement gives students insight into what a career in research or industry/professional practice might entail. Students in the Chemical and Bioprocess Engineering focus group had completed both, and felt they were well-placed to make an informed decision about their future careers.

I definitely think, especially we were given the opportunity to work in industry, that some people kind of get towards the end and they realise "No I would like to go on to further research" or you know, "like I definitely want to go into industry". So it does give you an idea. I suppose it kind of prepares you for what you want after you finish your Degree. So it [the programme] is good in that regard. (Stage 4 Chemical and Bioprocess Engineering)

One Chemical and Bioprocess Engineering student referred to completing an internship as doing "career research".

6.2 Research experiences augmented understanding of the potential importance of research in future careers

It is neither feasible nor relevant for all disciplines to provide both research and work placements to all students. However, for those disciplines where both a research project and a work placement were options (Agriculture and Food Science, Chemical and Bioprocess Engineering, and Physiotherapy), students discussed the revelation of the importance of research in their future career, particularly once they took part in the placement. They discovered how their professional decisions depended on the knowledge or skills acquired during research opportunities. For example, Physiotherapy students spoke at length of the realisation of the importance of evidence-based practice and how their clinical decisions had to be supported by relevant clinical research.

...when we are on placement they want us to be looking up research and want us to be finding the guidelines. So they kind of instil a sense of evidence based practice in us. So that is where we... how we know about research and why it is so important. (Stage 4 Physiotherapy)

The Animal and Crop Science students in the Agriculture and Food Science focus group, also undertake a 30 credit, nine-month placement in Stage 3. These students, like the Physiotherapy students, also spoke of the relevance of research to practice, and how this realisation occurred while on placement.

Before placement, you know, you are doing like nutrition and everything and you are learning all about the importance of the right minerals and elements... all of it like in dairy. To get the best yield and everything, and in the class like okay there is all this research that is great, but when you are out there and see how every day like, the milk yield and quality can be affected by simply the feed. If it is not mixed correctly, if there isn't enough minerals, or say if there something wrong in it, how straight away there is an effect on your herd and everything. I suppose you see how important the different elements of what we have been doing and how it plays out, and I suppose you get a better understanding and a better respect for what we are in and how important the research is for when it is implemented in a farm. The difference that it can make to that one herd or that one farmer in terms of the quality of the animal they have, the health, the milk they can produce, or like the calves; everything like. (Stage 4 Agriculture and Food Science)

Being on work placements gave students an insight into what the profession entailed that they may not have been aware of. For example some Physiotherapy students commented that they had not realised that practicing physiotherapists were also conducting research and encouraged to give in-service workshops and disseminate research findings.

Yeah, service developments as part of the job, and I hadn't realised that that was... that has become such a big part of jobs for physios in hospitals and probably in private practice as well; that like you need to be constantly doing sort of research or clinical audits. (Stage 4 Physiotherapy)

Whilst many students expressed an appreciation that undertaking undergraduate research could open doors for them in their future career, and enhances their career opportunities, some students felt that compulsory research projects potentially restrict their opportunities, particularly in the absence of an alternative such as a work placement. Whilst these students understood some of the value and benefits of research projects, and in some cases suggested they should be compulsory, this highlights the importance that students fully comprehend the relevance of the research process and the skills developed rather than simply doing research for research sake alone.

I kind of did chemistry because I wanted like a general background and I wanted a good Degree. But I didn't realise they would be kind of as keen on breeding us to do PhDs basically. Like I feel like I have no other opportunities in front of me bar doing a PhD. Like that is where industry placement would have been so handy like. Even for the people that are interested in doing research, at the end of the day they might do four years and then do industry. I think like research is good but we do need to have a bit of an understanding of what goes on in the real world. (Stage 4 Chemistry)

6.3 Research experiences instil confidence and improve employability

In several cases, students articulated how undertaking research gave them more confidence to move in to their chosen field, and a sense of accomplishment in what they had achieved and what they could achieve in the future. They identified how having the opportunity to undertake a capstone research project in a research-intensive university gave them an edge over other students in an increasingly competitive environment.

I think like it is very valuable for us to have the experience and to include it maybe if we are going for different Masters and stuff, because it will give us an edge over other people maybe that did courses that don't have that experience. (Stage 4 Physiology)

So it is great to see research that is being done now because it makes you feel like your degree is more up to date, and that you are not just getting to a certain level of intelligence. That you are actually um... getting to a level where you could possibly add to current research. (Stage 3 Arts)

Yeah, because I went for an interview recently for a PhD and if I hadn't got that experience in Ag, I would have been a little bit more green going into it. I wouldn't have been able to relay it back to my experiences and bring that up in my interview. (Stage 4 Agriculture and Food Science)

Students understood the value of their research skills to their employers in their chosen career on a national and international stage. Students heading for a career or further studies in research understood the value that a substantial undergraduate research project has for their prospects (Chemistry and Physiology). This understanding was also apparent in professional disciplines such as Agriculture and Food Science and Physiotherapy, and students pointed to greater credibility with employers and clients alike. Specifically, the Food Science students and the Physiotherapy students talked about how if their research project led to a publication, then this could be very beneficial for their future career. One Physiotherapy student mentioned how being engaged in research can be important for Physiotherapy students who might want to study or work outside Ireland after completing their degree.

I think the value of it really just being exposed to research in your undergraduate programme, for me anyway I think is... your credibility going into the workforce...

I mean if you are going into any company and any job, advisory roles or anything; you need to know what the latest for nutrition and feed and everything and grass growth and just all the different things that are out there. If you don't know I mean you are not going to progress in your job or you are not going to be any benefit to any company, if you don't know the latest and what is going on like. (Stage 4 Agriculture and Food Science)

...number one it is a good thing to have on your CV; and especially if you do get published, it looks really, really good, but then in terms of um... I think a lot of us were told that if you are looking to go abroad to work, that other countries really, really emphasise the importance of research and really appreciate somebody's participation. (Stage 4 Physiotherapy)

Interestingly, for both of these groups the research project is not core, but they appreciate that engaging in research as an undergraduate, can "give you an edge".

6.4 Research experiences provide a context for students' learning

Aside from helping students develop an appreciation for evidenced-based practice, a work placement can more simply impact students' learning in that by observing certain techniques and methods first hand, they appreciate the relevance of the theory they are learning in the programme.

When I was in PWE [Professional Work Placement] I actually was on one of the farms that [staff member's name] is carrying out his research [...] I actually ended up working for the factory where they are processing the end material as well. So I was able to really understand his research and it made it a lot more interesting sitting in the lecture and hearing him talking about and I could actually visualise each process and what exactly he means, which ties it all together very much. (Stage 4 Agriculture and Food Science)

Engineering students discussed a related point: how the recognition of research carried out by their lecturers in UCD and elsewhere made them realise that the fundamental principles of research they were learning were relevant and important.

*It is kind of motivational as well, because we are aware that the lecturers are doing cutting edge research. That means that Chemical Engineering is still cutting edge research and there is going to be jobs there and stuff like that. So that was kind of motivational.
(Stage 4 Chemical and Bioprocess Engineering)*

6.5 Research experiences enhance or develop discipline-specific and transferable skills

In terms of the value of research experience, students also identified the discipline-specific and transferable skills they developed as being of fundamental importance. The skills directly relevant to their subject were readily recognised by students from all disciplines, regardless of whether they experienced a substantial research opportunity at undergraduate level or were interested in research during or after their degree. For example, Business and Law students, who do not complete a Capstone Experience still understood the value of research skills, but appear likely to pursue professional qualifications rather than research opportunities and in general are more driven to begin work than other disciplines. Transferable skills including communication skills, data analysis, critical thinking, problem solving, independent learning, and use of appropriate reliable resources, were identified by students across all disciplines as being important. However, students who experienced a capstone research project or placement spoke with more confidence about the value to their future, and some felt there was an external perception amongst employers that disciplines strongly associated with research, such as science, produced students with a greater range of useful and transferable skills and thus had a competitive advantage for being hired.

*So it is worth it for that, but obviously you know, for research's own sake, the skills we learn as well as the qualification we get; I think it is worth it. We have become more independent and I think we do develop critical thinking, and also communication skills. In terms of reading, what can be very confusing research documents and then also in terms of communicating what you have learnt and writing. So there is a lot of transferable skills that we have learnt through it. Critical thinking and communication being the biggest two, I think.
(Stage 4 Chemical and Bioprocess Engineering)*

Because I know (my Dad) in business, when they would be hiring people, anyone with a science Degree, they would be like "Oh perfect, like we want them. They are critical thinkers, logical thinkers, they know how to research". (Stage 4 Physiology)

By Stage 4 students not only appreciate the importance of research and evidenced-based practice, but they have also become critical about research findings.

*Yeah, like before I probably was just looking up research just to have a reference or to tick the box "Oh I looked up an article", whereas now like [student's name] said, like I am actually like looking at the results and thinking about them and applying them rather than just sort of having... you know, fill in the gap on a page or whatever... that has definitely changed this year.
(Stage 4 Physiotherapy)*

Coming to a realisation that they have developed transferable skills throughout the programme, and have the ability to articulate what they are, is an important juncture for students. The following quote from a Chemical and Bioprocess Engineering student illustrates the student's realisation, during a work placement, that he/she had indeed developed problem-solving skills.

In the same way, it is even just how you go about learning. I think with engineering it is quite unique in that it is all problem solving, and like just speaking from personal experience, the internship I did last summer; although it was in an oil company and there were loads of people doing engineering projects; mine was really very engineering I suppose. But using the skills that you learn through like...like all our assignments would be "Solve this problem" and rather than having an engineering problem, I had say a human resource type problem. But you are still able to use those skills. So it is also about like teaching you how to research in a general basis, rather than just specifically "Oh there is a heat exchanger, I learnt about that in a lecture". It is like "Oh here is a problem, I know how to solve it because..." you know, kind of the methods you get there as well. (Stage 4 Chemical and Bioprocess Engineering)



7 The Capstone Experience



7.1 Background

Of the seven programmes where focus groups were conducted, five had a research project (RP) and/or a work placement (WP). A summary of the RP and WP components of these five programmes is presented in Table 4. Both the Chemistry and Physiology programmes incorporate a core RP worth 20 credits in Stage 4. The Chemistry RP is carried out over both semesters, and while the Physiology RP is scheduled for Semester 2, the students start the project in semester 1. Neither of these programmes has a core WP component.

Similar to the Chemistry and Physiology programmes, the Chemical and Bioprocess Engineering programme incorporates a core RP in Semester 1 and 2 worth a total of 15 credits, along with a core Design Project in Semester 1 of Stage 4, also worth 15 credits. While the programme does not offer a WP, students are strongly encouraged to participate in internships in their own time, especially in the summer between Stages 3 and 4. Members of the School actively assist the students in securing internships and almost all students avail of the opportunity. All eight students in our focus group had completed some form of internship; therefore, these students were well placed to comment on the quality and value of both an RP and a WP experience on their learning.

Physiotherapy students complete a number of clinical placements, the first, and most substantial of which, worth 30 credits, occurs in the first semester of Stage 3. While an RP is not a core component of the programme, students are offered to complete a group RP, worth 10 credits, as an option in Stage 4. Almost all students take this option, and all nine students who participated in our study had completed the RP. Consequently, they too could shed light on the quality and value of having participated in both WPs and a RP.

Students from two programmes, Animal and Crop Production and Food Science participated in the Agriculture and Food Science focus group. The Animal and Crop Production programme has a professional work experience (PWE) component worth 30 credits in Stage 3. These students do not have the opportunity to undertake a major (10 credits or more) RP as part of their studies. The Food Science students also complete a 16-20 week PWE worth 10 credits in Stage 3. However they have the option of taking a 10 credit RP in Stage 4, although places are limited. At least one student in our focus group had completed a RP in Food Science.

In the programmes with a RP component, students conduct their own research, making this an authentic research experience. In terms of nomenclature, we will use the term “work placement” as an umbrella term for what are referred to as internships, clinical work placements, and PWEs, depending on the degree programme involved. What the RP and WP have in common is that they are scheduled in Stage 3 or Stage 4 of the programme and are given special significance and status by virtue of being worth ten credits or more. For this reason we refer to them as “Capstone Experiences”. Using this definition, the Bachelor of Arts programme and Business and Law programme do not offer Capstone Experiences of this nature. However this does not mean that the students in these programmes do not engage in research or placements.

It is simply that the timing and credit weighting of the research and work placement components in the five programmes discussed above, means that they seem to have particular significance for the students’ learning experiences.

Table 4: Capstone Experiences from final year focus groups

Stage 4	Research Project Individual Sem. 1 & 2 (20 ECTS)	Research Project Individual Sem. 2 (20 ECTS)	Research Project Individual Sem. 1 & 2 (5 + 10 ECTS) Design Project Single/Pairs Sem. 1 (15 ECTS) Optional Placement	Research Project Group Sem. 1 & 2 Optional (10 ECTS) Clinical Placement (20 ECTS)	Research Project Individual Sem. 1 & 2 Optional (10 ECTS)**		
Stage 3				Clinical Placement (30 ECTS)			
Stage 2							
Stage 1							
	Chemistry	Physiology	Chemical and Bioprocess Engineering	Physiotherapy	An. & Crop* Food Sci.**	Bachelor of Arts***	Business and Law

*Animal and Crop Production

**Food Science

***Students spoke about studying Economics, English, English and Film, Geography, History, Irish, Mathematics, Music, and Sociology

7.2 Value of the Capstone Experience for Students' Learning

From our focus groups it is clear that the Capstone Experience provides a valuable, and unique, learning experience for students. We will mainly focus on the RP and the transformative effect it has on students' learning. Recall that an RP is core for the Chemical and Bioprocess Engineering, Chemistry, and Physiology programmes and that while an option for the Physiotherapy programmes, most students choose it and all of those in our focus group had completed one. There was at least one Food Science student in the Agricultural and Food Science focus group who had completed an optional RP. All RPs conducted by students in our focus group were in Stage 4.

As has been highlighted in section 4 above, engaging in an RP can increase students' awareness of academics' research areas, bring students into a community of researchers, and give students access to specialised research facilities especially if the project is laboratory based. Except perhaps for a WP component, no other research experience in the curriculum can rival the RP for the way it brings students into close contact with lecturers and their research, and frequently draws them into a community of researchers of academics, PhD students, and postdoctoral students. In this section we will turn our focus to how the RP specifically impacts students' learning. Given the emphasis placed on the RP by virtue of its position in Stage 4 and relatively high credit weighting, and the fact that by engaging in an RP, students are having an authentic research experience, we discuss how the RP provides a unique opportunity to enhance students' learning.

Based on our analysis the ways in which the RP adds value to the learning experience can be categorised as follows:

- (i) The RP consolidates and further develops students' research skills, and enables students to develop specialist knowledge
- (ii) The RP deepens students' understanding of the nature of research
- (iii) The RP provides students with an opportunity to make research contributions to their field/discipline

(i) The RP consolidates and further develops students' research skills, and enables students to develop specialist knowledge

As discussed in section 4, research experiences throughout the curriculum can enhance or develop students' discipline-specific skills, research skills and transferable skills. The RP gives students the opportunity to consolidate and further develop these skills, and apply them in an authentic context. For example, in addition to the data analysis and presentation skills developed throughout the programme, the gradual development of laboratory skills from Stage 2 through to Stage 4 was discussed in detail in the Physiology focus group. The Physiology students spoke about how engaging in the RP consolidated these skills, and resulted in individual students specialising in specific laboratory techniques.

We were kind of given an intro to all the [lab] techniques last year in our experimental physiology module and now this year it is like I am doing Western blots and QPCR. [...] I wouldn't be able to go off and do what [student's name] is doing or anything, even though we would have maybe done it in one of our labs last year; but like I would be obviously a lot better in my techniques now. (Stage 4 Physiology)

Students in the Physiotherapy focus group described how their data analysis and presentation skills, proposal writing skills, and the ability to write a literature review developed and consolidated as a result of completing an RP. In particular they discussed how they had received some training in the statistical package SPSS, but that it was not until they had their own data that they could develop a deeper understanding of the statistical analysis required. Since the data collected was unique to each group of students working on an RP, the academic supervisor was instrumental in helping the group build on the data analysis skills they had already developed and advising them on how to apply the techniques to the specific data set. Therefore in a similar fashion to the Physiotherapy students, they specialised in techniques that were most appropriate for their specific projects.

I don't think it [SPSS training] works well, but it is hard because all of our studies deal with such different data. There is no one workshop you can give. Like our data would have been very different to your data and how we input it and even how we analyse it and how will they do it then? Will they show one statistical analysis test on SPSS? Or will they show us twenty? And I think they gave us a good basis to go off and you know, the real basics of how to input data. So I think that went well. And then it kind of... well I know of us, it carried over that our supervisor then took us in and showed us different things that... different things that we had to do in relation to our study, that another group wouldn't learn. (Stage 4 Physiotherapy)

As seen from the two quotes above, engaging in an RP means that individual students or groups of students develop specific research skills that are likely to differ from those of others in the class engaging in other RPs. This is also true of specialist knowledge and throughout the focus groups where students completed an RP reference was made to how they had developed knowledge that was unique to them or their research group. One Chemistry student joked, "I know everything there is to [know] about sulphur", while another remarked:

I think you learn a lot about whatever area you are doing your research in. So in fourth year I learnt a lot more about organic chemistry and I am a lot more comfortable I think coming into the exams now because of it because I have been exposed to it for a whole year constantly. (Stage 4 Chemistry)

This is likely to be the first time in their degree programme where the content knowledge and skills developed differs from student(s) to student(s) and that students develop "expertise" in areas that may be different to their classmates. Interestingly, they often state a desire to disseminate what they have learned to others in the class. For example, a Physiotherapy student, whose research group had read a research article by a member of staff believed it to be relevant to their classmates.

Like only recently there when we were doing our research project, I came across like one of our lecturers had done research in an area that was highlighted in our dissertation. So it was only through that that I would have like read up her results and things like that, and then went to her and spoke about it. [...]

But then again that is only three of us that now know that paper... because we were the ones that went and looked it up. I think more people should be aware of it because it is so relevant to final year students. (Stage 4 Physiotherapy)

(ii) The RP can deepens students' understanding of the nature of research

Participating in an authentic research experience gives students a real insight into what is actually involved in conducting research, in a way that more contrived experiences earlier in the programme cannot. The difficulties and challenges arising from engaging in your own research were mentioned in a number of the focus groups. A Physiotherapy student remarked that you can be taught how to conduct research, but it is not until you are actually doing your own that you develop a real understanding of what is involved.

Like I think first to third year; and especially with that research module in third year; you are sort of given the building blocks on, you know, what is involved in research projects. But it is not until fourth year when you are doing your Dissertation One, that you really hone in and get more sort of almost a different viewpoint on what is actually involved in research and like, you know, sort of the complications or the difficulties that come from it that you wouldn't... like it is sort of easy to just learn like how to do your research project or the different things that are involved, but it is not until actually partaking that you actually have to apply what you have learnt, that you kind of get a different understanding of what is involved in it. (Stage 4 Physiotherapy)

The students in this focus group gave specific examples of the challenges in analysing data, conducting trials on a large number of participants, and the difficulty in recruiting participants for a study. However, it is important to note that the difficulties encountered led students to develop an appreciation for what is involved in conducting a research study.

You definitely have more of an appreciation, even a simple thing today when you handed out the questionnaires in class. I said to one of my friends in my dissertation group "How are they going to analyse this?" you know and have to collect all that data. Because we had to do it ourselves for one aspect of it and we thought "Oh I don't know how they do that, the work behind it is huge", and you take that for granted sometimes when you don't really understand. It is only when you do it yourself and have to apply it yourself, that you realise how much work... (Stage 4 Physiotherapy)

The Physiology students felt that their laboratory sessions in Stages 1 and 2 were set-up, perhaps in an unrealistic way, to give them certain results, but they appreciated that real-life research was not like that and that an important skill was to be able to figure out why an experiment may not be giving you an anticipated results.

I know like in second year we were just given results to talk about and you kind of progressed to "Ok, now it didn't work, what will we do?" and now we are in situation where sometimes they work, sometimes they don't, and what are you going to do about it? (Stage 4 Physiology)

Similar to the Physiotherapy and Physiology students above, across the focus groups that had an RP component, students discussed how you can "be taught" about things such as conducting statistical analysis or carrying out laboratory techniques, but it is not until you have to apply them in a real context that you truly understand and appreciate them.

Given the length of their RP, the students in the Chemistry focus group seemed to have a well-developed understanding of the nature of research and they spoke about the hours that must go into research in order to get results. The length of their RP seems to allow students to engage deeply with research and one student spoke of how "you can get lost in it" and of how when conducting research, rather than arrive at a conclusion, you often come up with more questions that you want to explore.

If you told someone you spent twenty one weeks doing something, they would say "Is that all?" but actually it is an enormous amount of stuff because everything you do, there is eight more things you have to do with that result now. Paths to follow. So you kind of have to pick one and come back and follow another path and come back and every time there is just more and more stuff to do. (Stage 4 Chemistry)

Of course a distinctive feature of the RP is that one must produce one's own results and develop one's own knowledge about the project. While experiences earlier in the programme can attempt to assist the student in developing knowledge and skills which may be used and applied in the RP, due to the distinctive nature of each project, students, of necessity, must be able to work independently and take initiative. However, the supervisor also has a role to play in scaffolding students' learning in the RP and supporting them through it. Students understood that it is the nature of research to engage in independent work, yet rightly felt that they must be adequately supported along the way. In a number of the focus groups there was discussion around this tension – how to do your own work, yet be adequately supported and what level of support should be offered. In referring to a literature review that had to be conducted before embarking on their RP, a Chemical and Bioprocess Engineering student spoke about the assignment had helped him/her to think about the nature of research in the discipline.

We had to do a literature review for the research project, which is a kind of critique of the current standing of research into a topic. So you talk about what the research has shown so far and what the challenges are that needed to be overcome before more things can be taught and learnt. So like the challenge might be the experimental equipment isn't there to get the level of accuracy you want or the challenge might be you know, this is just too expensive to do, or something. So it was... I suppose you had to think critically about what research is and what it is trying to achieve and what the challenges to research are, in order to do well in that literature review. So that was good. (Stage 4 Chemical and Bioprocess Engineering)

However a fellow student disagreed that the experience had been a positive one and felt that he/she was "just floundering" when it came to the literature review, even though he/she understood that "this work has to be autonomous and things like that and that is the point of research". The issue of whether they had been "taught about research" arose again in the same focus group with one student responding: "But is that the nature of research, where you are given a basic statement and you just go from there?" We will return to this point later, as in particular it poses a challenge for staff who incorporate RP into their programmes as to what level of support should one provide for students conducting research.

(iii) The RP provides students with an opportunity to make research contributions to their field/discipline

Research is information gathering and then also there is research where you are creating new information. We only did information gathering like looking up websites, reading papers, up until the first semester of fourth year. The only time we ever actually go into a lab and produce new information and run experiments is the second semester of fourth year. So that is the only time we do, you know, brand new research... (Stage 4 Chemical and Bioprocess Engineering)

Engaging in an RP and conducting "brand new research" means that there is an opportunity to make an original contribution to the discipline, even in just a very minor way. The nature of the RP, specifically the length and credit weighting, has an impact on the amount of research students can realistically carry out.

Given that the Chemistry students' RP is 21 weeks in duration, is worth 20 ECTS credits, and the fact that they are usually part of a team of PhD students, postdoctoral researchers, and academics, these students were particularly aware that it is possible to make an original contribution, even if it is just as a small part of a much larger project.

You are contributing to a larger project with a small amount of results, and all of the results mean something more to the larger picture I guess. (Stage 4 Chemistry)

In weighing up the pros and cons of doing a group RP, one reason that a Physiotherapy student gave as an advantage of a group project is that one can have more participants in the study, and hence increase the chances of having the research published, which is very desirable.

So if you are doing study on your own... like we had sixty or seventy involved, there would be no way I would be able to do a study or test on seventy people in a few hours. So having five [people in our group] we were able to carry out that. So obviously having a bigger sample size your results are going to be better and you might have a chance of being published; which would obviously open opportunities, and it is always a good thing to have on your CV. (Stage 4 Physiotherapy)

While not necessarily related to getting published, a Physiotherapy student spoke about how, because of the research for the dissertation, he/she was able to contribute to a cycling course that was being set up while out on placement.

When I was working in [service name] in [town name] on my placement, then they were looking to start up a cycling course and I happened to say that that was the dissertation I was working on and then they asked me to be involved in that. (Stage 4 Physiotherapy)

The discussion in this section has mainly centred around the impact an RP has on students' learning; however, it is necessary to return to the WP briefly as we also define it as a Capstone Experience. The Agriculture and Food Science students along with the Physiotherapy students had core WPs embedded in their programmes and there was quite a lot of discussion in both of these focus groups about the impact the WP had on their understanding of the role research plays in professional practice. To a lesser extent, they spoke about how engaging in a WP also increased their awareness of academics' research areas. We have already elaborated on this in section 4.

All of the Chemical and Bioprocess Engineering students in our focus group had completed a voluntary WP (generally, a summer internship) but the discussion in this focus group tended to centre on how the experience had given them insight into what future career they might like to pursue, and on the realisation that they had developed skills throughout the programme which they could easily transfer to the workplace. Again, this has been presented in section 4.

7.3 Value of the Capstone Experience for Future Career

Completing an RP or WP enables students to make informed choices about what a career in research or industry/professional practice respectively might entail. For the students in the Chemical and Bioprocess Engineering focus group and the Physiotherapy focus group who had completed both an RP and WP, they felt they were very well-placed to make an informed decision about which career path to follow.

Students expressed a keen awareness that the skills developed both throughout the programme, and specifically by engaging in an RP and/or WP, are transferable and make them more employable. All of these points were presented in section 4, therefore we just summarise them here as follows:

- (i) Completing a RP or WP encourages students to consider a career in research or industry/professional practice respectively
- (ii) The skills developed throughout the programme and by engaging in a RP or WP are transferable and make students more employable

7.4 Quality and Logistics of the Capstone Experience

In each of the five focus groups from programmes that had an RP and/or WP, there were some really interesting, and often contrasting views on factors that affected the quality of these research experiences. From the educator's perspective, designing, implementing, managing, and assessing an RP especially, is challenging and is often fraught with difficult decisions about the timing, length, difficulty of project, and level of support which should be offered.

The students in our focus groups were not of one-mind on some of these issues, and the arguments offered on both sides may be illuminating to educators. Therefore we very briefly present some students' views in relation to the following questions:

- (i) How long should an RP be?
- (ii) How should RPs be assigned, and specifically, should students propose their own RPs?
- (iii) Should RPs be carried out as part of a group, or individually?
- (iv) How much support should students receive during an RP?
- (v) Should an RP and/or WP be core in an undergraduate programme?

(i) How long should an RP be?

The Chemistry students complete a 21 week project and they spoke about how the length of their project enables them to have a more authentic experience, and gives them a sense of what it might be like to complete a PhD.

...So we get a much more... like it is a proper project, or as in length wise, I mean like it is a long project and you have a defence at the end and that is more like a PhD and you have a presentation in the middle of it on the kind of unfinished results, which is like a PhD. So it is a bit more realistic in that sense. (Stage 4 Chemistry)

The Physiology students spoke of how their project had to be completed within 11 weeks and that they had to work intensely on it.

Even time wise, you see compared to other streams in science, our project is an awful lot shorter and I do feel it is a bit more intense and I wouldn't say that to the others...because I am demeaning their project. Obviously they worked just as hard but they get a huge timeframe compared to what we get. We just hit the ground running and in eleven weeks; not even the full twelve; you just have to have your thesis up and that is it. Whereas a lot of the streams have spent last semester doing their own lab work with no modules... (Stage 4 Physiology)

The Physiotherapy students discussed whether an RP should run over one or two semesters. They spend part of semester 1 in Stage 4 on placement, and their RP is over both semesters. It was noted that while it was challenging to complete a research project and placement concurrently, the longer timeframe meant that it was possible to carry out interventions with pre- and post-testing, which could not be achieved in a shorter timeframe..

I can understand how people would have difficulties if there was like an eight week intervention if they had to have pre- and post-testing, that it puts the group under a lot of pressure to start their intervention early and do all their pre testing; they might even have to start during the summer as opposed to starting in September. So that would put them under pressure to then do their intervention, get their results, and do their write up; maybe in the space of only a week or two when it has to be submitted. So in terms of having that time to collect your data and then analyse it and write it up well and even to do a number of drafts; I think that maybe having it a yearlong has been beneficial; but then doing it over a placement is quite difficult as well, because it is quite hard to focus on two things at the same time. (Stage 4 Physiotherapy)

(ii) How should RPs be assigned, and specifically, should students propose their own RPs?

In terms of how RPs are assigned, a few different suggestions arose. The Chemistry students spoke about how the lecturers proposed different projects and students then went to speak to them individually about the projects on offer. The Chemistry students did not raise any negative issues relating to how projects were then assigned. On the other hand, both the Physiotherapy and Chemical and Bioprocess Engineering students expressed some dissatisfaction with the method of assigning projects. The Physiotherapy students were asked to express their preferences for an RP from "twenty something options", but felt "it was kind of luck of the draw what you did get at the end of the day". The Chemical and Bioprocess Engineering students stated that having input into the type of project they were assigned could increase motivation, a view that was also echoed in the Physiotherapy focus group.

I think it would be really nice if for our final year research project, we had some part of the decision on what we picked. Because like some people get to do lab work and collect data and analyse that, and some people it is like purely modelling or whatever, and if you have already... because a lot of people by the time fourth year starts, have a solid idea of what they want to go on to do and you are doing a research project that is totally different, it is hard to stay motivated and you are also probably not getting as much out of it as you possibly could. So I mean even if you just had a say like "I would rather do lab work than modelling" or "I am already signed up for a job that is in oil and gas, can I do a research project that is along those lines?" I think that would be helpful. (Stage 4 Chemical and Bioprocess Engineering)

One Physiotherapy student felt strongly that the fact that they were not allowed to propose their own RP hampered their autonomy and independence, and proved a contradiction for the type of learners they were being encouraged to become.

So I kind of found personally that in first, second and half of third year we were really kind of taught to be self-directed, independent, autonomous learners, and then when it came to the crunch in the final year and a half, when it counts towards GPA, we were asked to carry out research whereby the idea was formulated by someone else. So that was ... that kind of contradiction was something I didn't really understand. (Stage 4 Physiotherapy)

On the other hand another Physiotherapy student was pleased to be presented with a list of projects, as the RP he/she had completed had been proposed by an outside UCD partner, and therefore it was an RP that had a real-life, and relevant, context.

... it was nice that the lecturers gave us these topics or like for my topic it was [service name] who came with the topic and brought it to us. Because then you know that the gap has been identified in the literature and you know that the research topic is topical. (Stage 4 Physiotherapy)

(iii) Should RPs be carried out as part of a group, or individually?

The Chemistry and Physiology students complete individual RPs, while the Chemical and Bioprocess Engineering students complete their RPs either individually or in pairs. The Physiotherapy students on the other hand complete group RPs, and as might be expected the resulting experience was variable.

So I think it is kind of varied from group to group how well that has actually worked. Like some groups have worked really well and then other groups have struggled. Like maybe like you spend a lot of time then trying to organise group meetings and work with everybody else. (Stage 4 Physiotherapy)

However, as has already been mentioned previously, one Physiotherapy student felt the fact that they engaged in group projects meant that they could accommodate a greater number of participants in a study, and hence increase the chances of having their research published. Another believed that working in a group was a more authentic experience to how research would be conducted usually.

(iv) How much support should students receive during an RP?

This issue was touched on above in the context of how completing an RP can deepen students' understanding of the nature of research. In particular, we discussed how students in the Chemical and Bioprocess Engineering focus group grappled with the tension of engaging in independent research, yet feeling appropriately supported. In section 4 we also highlighted that, perhaps unsurprisingly, that students in a number of focus groups felt they could have been better supported at different junctures in the programme. Undoubtedly the role of the supervisor is key in scaffolding the student's research experience, and this can differ from supervisor to supervisor as illustrated in the following two comments.

I think it comes down to who you have got as your supervisor. So I met up with my supervisor every week; if not every two weeks; where I would give a draft... like you know, we came up... we agreed to sort of chapters and then I would do a page or two on the chapter and be like "Is this what you are looking for?" and he would say yes or no. and then that is how it went along. So I think I had a lot of direction, which is helpful.

Just in contrast to that, I have met my supervisor twice in the last six months. (Stage 4 Chemical and Bioprocess Engineering)

(v) Should an RP and/or WP be core in an undergraduate programme?

Finally in this section, we are aware that educators may also question whether a programme should contain a core RP and/or a core WP. As can be seen from our findings, both provide unique benefits for students' learning. Across the five focus groups in which students completed either an RP and/or WP, students presented arguments as to why programmes should in fact contain both. The Chemistry and Physiology students for whom there is no core or optional WP, felt they would have benefitted from one.

The only thing is I don't know if it is more recognised that, you know, UCD is very well thought of research and stuff like that, whereas if you wanted to go straight into industry work... I don't know, and I know it is not a fact in this but I have just heard like the say the likes of DIT would be more technical based and they tend to get a lot of lab-based jobs purely because they have got placement. They have done a placement as part of their course. (Stage 4 Physiology)

I don't know of any of my friends in any other college that don't do some sort of industry placement in science courses. So while we do a research project and it is fantastic, it is absolutely at the expense of industry experience and we are kind of bred to continue into research like living. It is not a choice for us. They are priming us from first year to continue down that road. (Stage 4 Chemistry)

Meanwhile the Physiotherapy students who had completed a core WP and an optional RP, believed the RP should in fact be core for all students on the programme, even for those who planned to continue in professional practice.

So I think it nearly should be core that we do our dissertation module in fourth year because I think it is so important and especially going forward with all like the jobs in the hospitals expecting us to do research. So that we should have done research ourselves to build on that and to become better at it. (Stage 4 Physiotherapy)

Some of the students in the Agriculture and Food Science focus group, while having completed a WP, felt disadvantaged at not having had the opportunity to engage in an RP. They felt that by not having the opportunity to have completed their "own research", they now lacked confidence to undertake research in the future.

I think just there is... say if there is Agri-environmental Science students and there is Food, and Ag and Business, and Human Nutrition as well. They are doing... carrying out their own research work, they have theses to do like. Whereas I wouldn't have. I have a number of projects to do but it is not my own research. So in that sense I have a lack of those research skills. Like going in and setting out your set of questions and then going about answering them and doing surveys and whatever else. So I think that might be lacking in my programme specifically. (Stage 4 Agriculture and Food Science)

Yeah, like as in animal science, like as in we were given that EDDA [Experimental Design and Data Analysis] module, but that like that was going through like kind of how to understand what is going on when you are reading a research trial. But personally I don't think I could conduct a research trial myself. (Stage 4 Agriculture and Food Science)

8

An Emerging Framework – Development of Research Skills

The reflections of the final undergraduates looking back at three or four years of learning were particularly insightful for us. We asked them to reflect on “what worked well” and “what worked not so well”. A common thread that persisted through a number of the focus groups was the issue of students feeling that they were not adequately prepared to engage in research when it was expected of them in the later stages of the programme. Examples given were not knowing how to conduct a literature review or write a critical essay; not knowing what statistical techniques were necessary to analyse research results; not knowing how to engage with a module that was based on current research findings, with references from the literature providing the main resource; and, not being familiar with which laboratory techniques to use in their research study. Students referred to “jumps” between Stage 2 and 3/4 and spoke of the feeling of “being thrown in the deep-end” when having to engage with research. Students admitted that they had taken some modules where the development of some of these research skills had been emphasised and addressed, but complained about the timing of these. Often when the modules were taken (in Stage 1 or 2) the students did not really appreciate what they were meant to learn from them and they seemed out of context, and then when the time came for them to apply the techniques or skills in Stage 3 or 4, they had forgotten what they had learned and/or could not see how the skills or techniques could be applied to their specific research.

After an initial analysis of the data, we decided to further explore the development of research skills throughout a programme. We analysed the seven final year focus groups to (a) identify specific research skills referred to by the students as being essential for their given programme; and (b) attempt to trace the development of these research skills through the three or four stages of the programme (where possible). Examples from our analysis for the Physiology and Physiotherapy focus groups are provided by way of illustration in Appendix 3.

Our findings suggest, perhaps not surprisingly, that it is essential to take a programmatic approach to research skills development. For a given programme, the specific research skills that students are required to develop should be clearly articulated in the programme outcomes, and to all staff and students on the programme. Secondly, these skills should be embedded in the curriculum from first year to final year in a “spiral” model – the student engages in tasks at each stage of the programme in order to further develop a given skill, and to encourage the student to become a more autonomous researcher. Our initial findings of good practice in the development of research skills are illustrated in Figure 1 below.

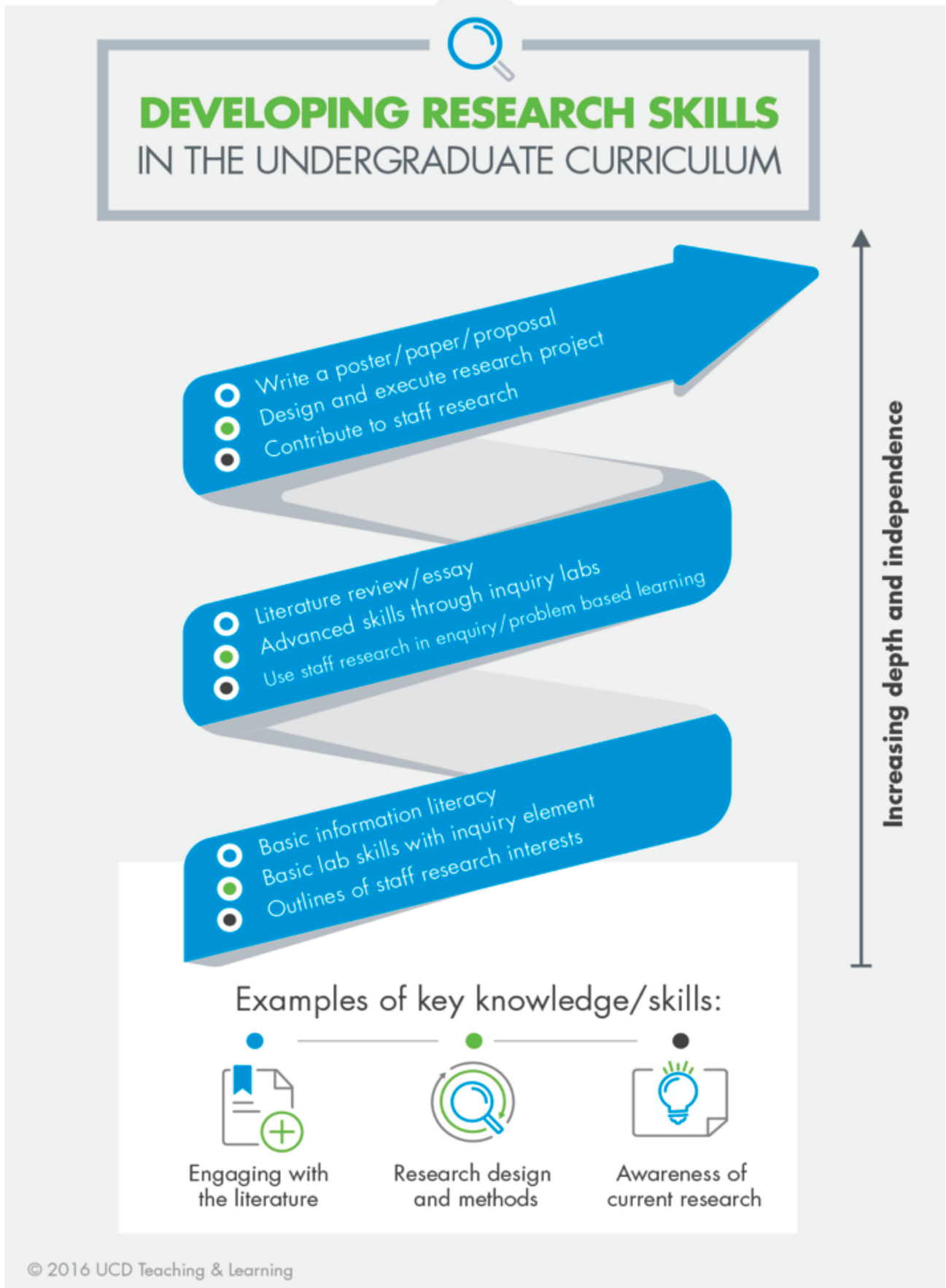


Figure 1 Developing research skills using a spiral model in the undergraduate curriculum

9 Conclusions and Recommendations



The results of this study show that there is a high awareness of research among undergraduate students in UCD, developing from a general awareness in Stage 1, to knowledge of research interests of individual staff in final stage. The study also provided a detailed account of how that awareness develops. The most common vehicle is through staff bringing their research, and that of their colleagues, into the curriculum, and that is viewed very positively by students. Not surprisingly, awareness is enhanced in programmes in which research skills are given greater emphasis, especially those in which students have a substantial research or professional placement experience. Despite the broadly encouraging picture that emerges from these results, it is clear that awareness of research sometimes develops in a rather unstructured and piecemeal fashion, and that some students do not become aware of the larger context until late in their studies.

Recommendation 1: More should be done, especially in early stages, to clearly articulate to students what research is (in the context of the discipline), how it is conducted, why it is important to them, and how it will be embedded in their programmes. Achieving this may be tricky in 'common entry' programmes (e.g. BA and BSc), but is, arguably, all the more important in those contexts, and should be achievable with coordination at College level.

It is clear too that research and research skills are embedded in our programmes in many different ways, and at every Stage, with the result that most final stage students feel that they have mastered the skills that they need for their careers. The emphasis placed on such skills varied by discipline, in line with the different graduate attributes required in different fields. On the downside, some students felt that the way in which research skills were developed within their curricula was not fully satisfactory, pointing to deficiencies in the sequencing of courses, and expressing dissatisfaction with research skills modules that were taught in isolation from research experiences.

Recommendation 2: It is important to take a programme-level view of the development of research skills and to design a carefully sequenced set of modules that will allow students to gradually develop the complex skills involved, and to get meaningful experience of applying them (see the 'spiral model' in Figure 1). Finding the required space in crowded curricula, especially in 180-credit programmes, may be a challenge, but active learning of research skills is extremely important in the UCD context.

It is gratifying that a large majority of students believe that including research and research skills in their curricula was important and valuable. Students understand the importance of the discipline-specific and transferable skills that are developed in research experiences, and recognise their relevance to their career aspirations. Strong research-teaching links are welcomed by students, as well as by staff. From our focus groups it is clear that a capstone Research Project can provide a particularly valuable, and unique, learning experience. The RP enables students to develop specialist knowledge, deepens their understanding of the nature of research and provides an opportunity to make research contributions to their field/discipline. Completing a RP or WP encourages students to consider a career in research or industrial/professional practice, respectively, and the skills developed make students more employable.

Recommendation 3: Whenever possible, programmes should contain an authentic research experience, ideally a late-stage project or work experience (if relevant) worth 10 credits or more. The importance of providing substantial research experiences will vary with the disciplines, but even from the perspective of the development transferable skills, there is a strong case for such experiences. Again, there are many challenges, and it is very important that the logistical issues detailed earlier be addressed in the development of research experience modules.

The holistic, programme-level view of incorporating research into our programmes outlined above may be conceptualised as the development of students' skills and identities in the context of 'communities of practice'. Support from staff was highlighted as very important by students, particularly in relation to problem-based learning modules (e.g. "Principles of Scientific Enquiry" in the BSc programme) and research projects, and it was acknowledged in some focus groups that support could vary across staff members. There may be opportunities to harness that community more effectively in building stronger research-teaching linkages, e.g., by making postgrads more aware of the issues as part of their training, or by supporting student societies more strongly.

Recommendation 4: It is helpful to view students' learning from the early stages of their undergraduate programmes to the completion of those programmes, and, in some cases, to postgraduate programmes, as a journey from being novices to becoming expert practitioners. Everyone involved in guiding students on that journey, including peer teachers, postgraduate tutors, postdoctoral research advisors and academic staff, has a role to play in the 'formation' of the next generation of experts and researchers. A key distinguishing characteristic of a research-intensive university is that most of the teachers are practitioners of their disciplines, and that their role as teachers is often secondary to that expert status. We, the research-active staff of UCD, should view our students as potential future colleagues, and design our programmes to facilitate their journeys to full membership of our community.



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Appendix 1

We are conducting a study of research teaching linkages at UCD, focused on the experiences of undergraduate students. We would be very grateful to you if you would take a little time to respond to our questionnaire.

1. In relation to the following, please answer Yes or No and if you can recall, please enter the stages/years (e.g. 1st year, 2nd year, 3rd year, 4th year) where you had the experience.

Awareness: Are you aware of any of the following in UCD?	Yes	No	Stage (1, 2, etc.)
Research posters/exhibitions/displays			
Books, journal articles and other forms of research/ output (e.g. images, performances, artefacts, devices and designs) produced by UCD staff			
Research seminars/conferences in UCD			
Advertisements within UCD for research and postgraduate opportunities			
Existence of Research Centres			
Existence of Research Laboratories			
Areas/people within UCD with international research reputations			
Experiences: While at UCD, have you.....	Yes	No	Stage (1, 2, etc.)
Undertaken research for a project			
Undertaken research for an essay/assignment			
Formally presented your own ideas/research			
Read research reports or journal articles			
Listened to a lecturer talk about research (his or her own, or other)			
Listened to a lecturer talk about how research is conducted			
Read a research paper, report or book written by a member of UCD staff			
Attended an artistic performance or exhibition linked to your subject area(s)			
Learned about research methods			
Developed research skills			
Acted as a research assistant within UCD			
Been invited to a research seminar			
Attended a research seminar			
Been invited to a research conference			
Attended a research conference			
Engaged in problem solving			
Engaged in problem-based or inquiry-based learning			
Engaged in group work			

2. Please complete the following sentence

When I think of research and teaching at UCD, I think...

3. Do you have anything more to say about research and teaching, and the link between them, at UCD?

4. Are you? (Please tick) Male Female

5. In what year did you complete your secondary education? Please state year _____

6. Please indicate your highest academic award: (Please tick)

Leaving Certificate or equivalent Other (Please state) _____

7. What career plans do you have for when you graduate from this degree programme?

Please state _____

8. Are you? (Please tick) Irish EU (Non Irish) Non EU Nationality

Appendix 2:

Sample Focus Group Schedule

FOCUS GROUP SCHEDULE (STAGE 4 CHEMISTRY)

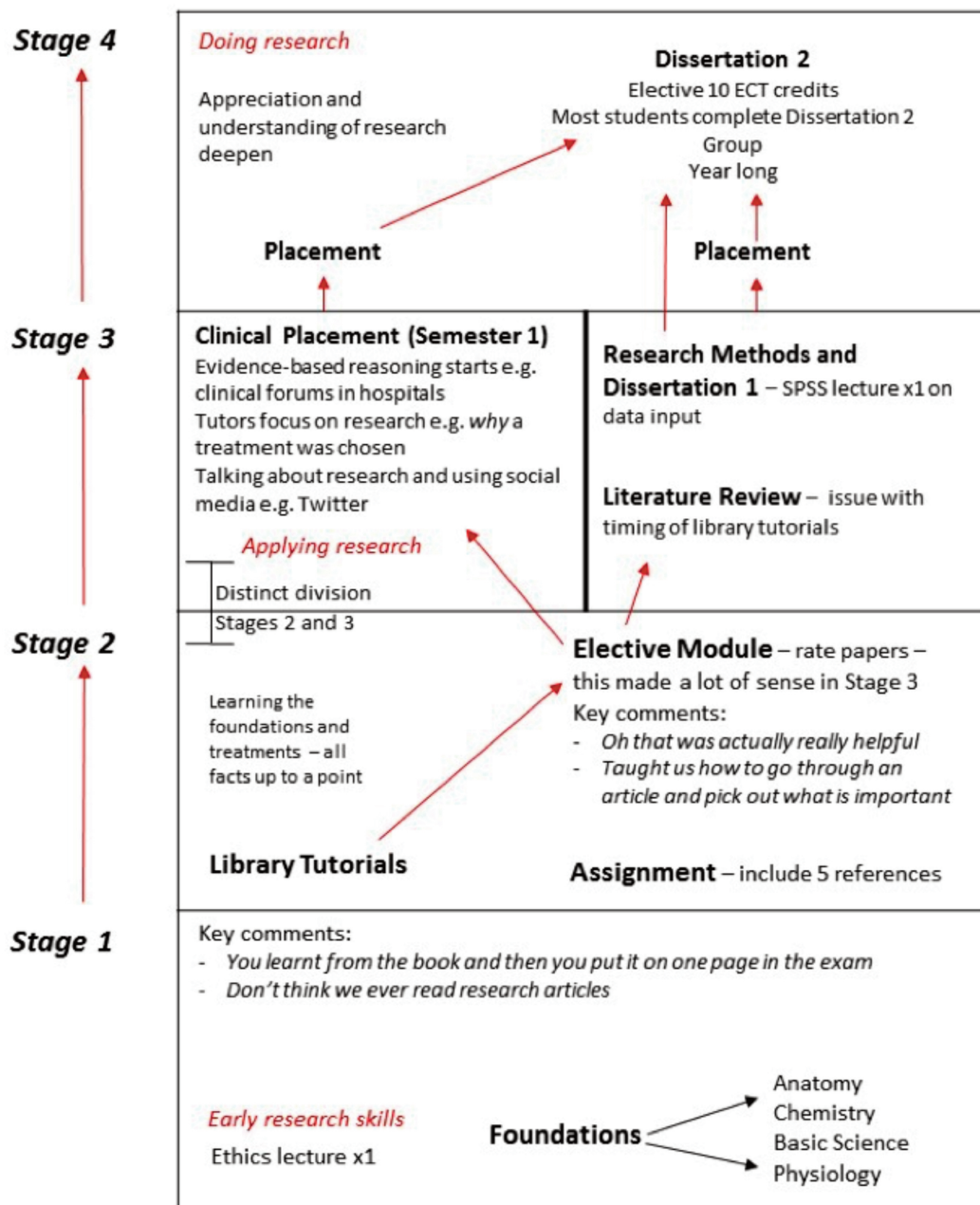
Aim: To examine undergraduate student awareness of, and exposure to, research in their discipline/programme, and their perceptions of how studying at a research-intensive university has impacted their learning.

1. Are you aware that research is conducted in UCD?
 - i. Tell me a little about that.
 - ii. How did that awareness develop?
2. What is your understanding of what it means to do research in Chemistry?
 - i. Tell me a little about that.
 - ii. How did that understanding develop?
3. Are you aware of UCD staff in Chemistry conducting research?
 - i. Tell me a little about that.
 - ii. How did that awareness develop?
 - iii. Can you talk about what do you know of their research?
 - iv. Can you explain how that knowledge developed?
4. Can you identify any instances where you have learned about research, been taught about research, or had any research experiences, during your studies here at UCD?
 - i. Can you outline any specific examples? (For 1st Year, 2nd Year, etc.)
 - ii. What worked well, and what did not work so well? Why was that?
 - iii. Would you consider that you had research experiences or been taught about research in SCI10010 "Principles of Scientific Inquiry", and if so, how well did that work?
5. I'd like you now to talk about the ways in which your awareness and experiences of research here at UCD impacted on your learning here at UCD.
 - i. Did that change over the course of your degree?
 - ii. When did that change (those changes) happen?
 - iii. Why did that change (those changes) happen?
6. Do you think that it is valuable to include experiences of research, and/or learning about research skills, in undergraduate programmes?
 - i. In what way?
 - ii. Do you think that your Programme has provided adequate experience of, and training in, research skills? Explain.
7. We have come to the end now of the focus group. Before we finish up, is there anything that you would like to add?

Thank you for participating in the focus group. We appreciate your contribution very much

Appendix 3: Final Year Focus Group Models

Focus Group – Stage 4 Physiotherapy



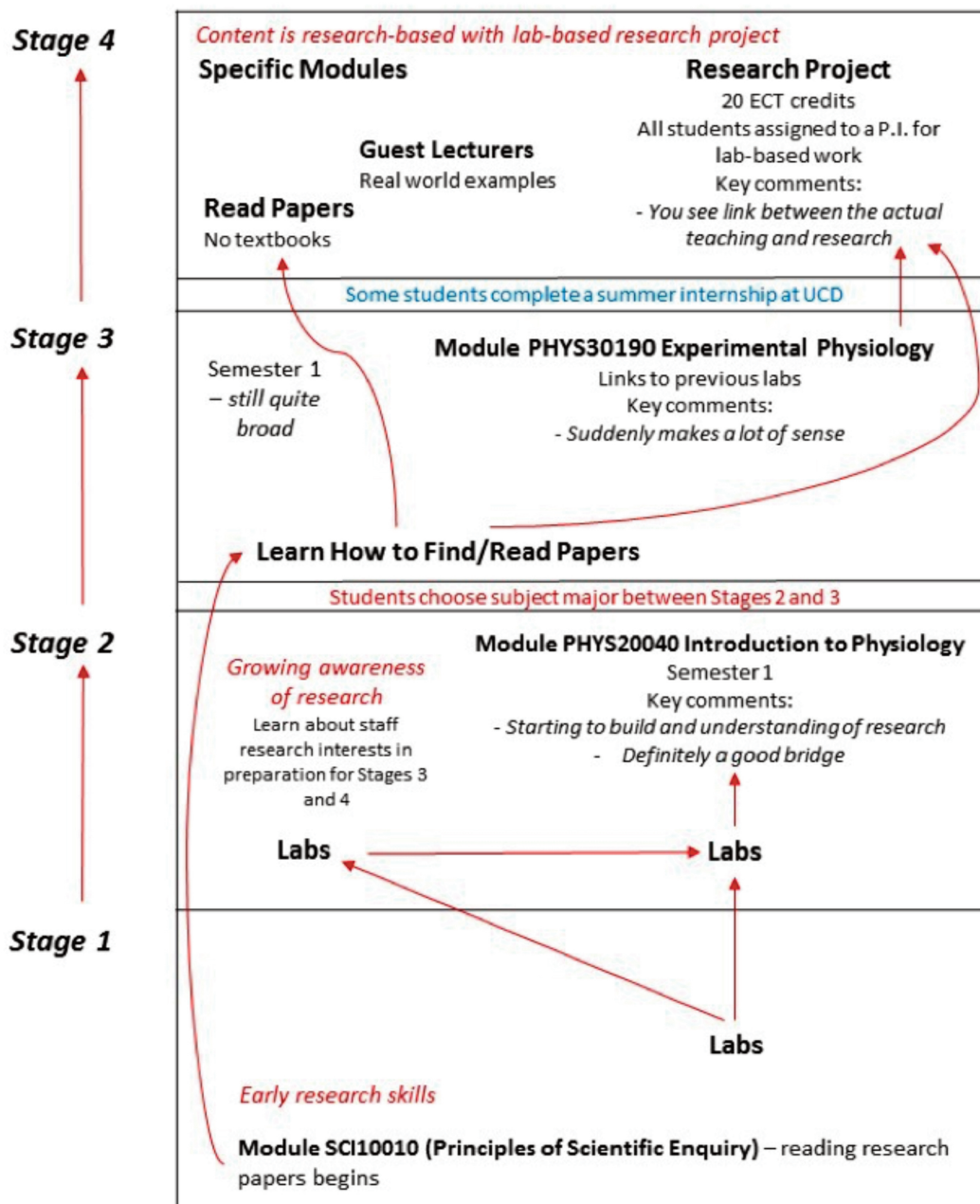
Notes:

Research appreciation was evident in this focus group
Awareness of research interests of staff increases from Stages 2 to 3 as students begin to look towards research project and staff place more emphasis on research

CATALYTIC MOMENTS

Research project
Clinical placement } Combined act as a catalyst for research

Focus Group – Stage 4 Physiology



Notes:

2 big research skills (evolutionary) – 1) Development of lab skills in a very broad sense including interpreting results and culminating in the research project, 2) Reading research articles

AGENTS/CATALYSTS – PHYS20040, PHYS30190, reading research papers in Stage 3, and carrying out the research project

Through our research intensive environment, a UCD education will be further enriched by the quality of our research and innovation and will develop our students' capacity for critical enquiry and original thinking.

UCD Strategy 2015-2020

