Assessing the Value of Authentic Learning: an integrated study of the impact of an undergraduate research placement (‘sandwich’) year on students’ academic performance, employability skill set and career aspirations

Sarah K. Hall
Cardiff School of Education, Cardiff Metropolitan University

This dissertation is in partial fulfilment of the requirements of candidature for the degree of M.A. (Education)

May 2016
DECLARATION:

This work is being submitted in partial fulfilment of the requirements for the degree MA (Education) and has not previously been accepted in substance for any degree and is not concurrently submitted in candidature for any degree.

Signed: (candidate)
Date:

STATEMENT 1:

This dissertation is the result of my own work and investigations, except where otherwise stated. Where correction services have been used, the extent and nature of the correction is clearly indicated. Other sources are acknowledged by footnotes giving explicit references. A reference page is appended.

Signed: (candidate)
Date:

STATEMENT 2:

I hereby give my consent for my dissertation, if accepted, to be available for photocopying and for inter-library loan, for deposit in Cardiff University’s e-Repository, and that the title and summary may be available to outside organisations.

Signed: (candidate)
Date:
ABSTRACT

This project aimed to investigate the authentic learning experiences of Biomedical Sciences students who undertake integrated research placements as part of their undergraduate degree schemes. It reports a longitudinal case study of students enrolled on placement during the academic year 2013-14. The project comprised a qualitative assessment of students’ opinions and perceptions before and after their placements, using questionnaires to collect this information. Such qualitative information was triangulated against a quantitative study of the students’ academic performance. This involved statistical analysis of summative assessment data from standard end-of-module and end-of-year assessments. Student identity was anonymised in all aspects of the study. The results of this project provide evidence for clear academic, professional and personal benefits to students undertaking research placement degree schemes in the Biomedical Sciences at University X, even when prior academic performance is taken into consideration. Novel findings include demonstration of the positive effect of the placement on final year research project performance. The results of this study will be used to inform and improve students’ authentic learning experiences on 4-year (placement year) Biomedical Sciences degree schemes at University X, and the findings may also be applied more generally across the higher education sector.
ACKNOWLEDGEMENTS

With thanks to:

- The School of Education at Cardiff Metropolitan University (particularly Cecilia, Jill and Tammy), for introducing me to the principles and practices of pedagogic research. It has been particularly enlightening to be on the ‘other side’ of the classroom.

- The students who agreed to participate in this study, who were intrigued and then delighted that I was also enrolled as a student and who inspired me to complete this project when I had so many other things to do.

- The School of Biosciences, for partially financing my studies, and my colleagues, for their support and interest in this project. Particular thanks to Dr Richard Cowie, for his help extracting marks from our SIMS database, Dr Rob Thomas, for introducing me to R software at the eleventh hour, and Dr Jeff Allen, for finding time to be my ‘critical friend’.

- My family and friends, for encouragement, reassurance and lots of cups of tea.

“Shall we educate ourselves in what is known, and then casting away all we have acquired, turn to ignorance for aid to guide us among the unknown?” Michael Faraday
4.2.1 The placement year student as ‘employee’  
4.2.2 Skills and attributes of the placement year student  
4.2.3 Returning to university  
4.2.4 Research placement and the final year project  
4.3 Research Question 3: How does the research placement year influence students’ career aspirations?  
  4.3.1 The placement year student as ‘scientist’  
  4.3.2 Post-graduate employment and training  
  4.3.3 Students’ overall evaluation of their placement experience  

5. CONCLUSIONS AND RECOMMENDATIONS  
5.1 Key findings  
  5.1.1 Summary of the findings relating to Research Question 1: How does completion of the research placement year influence students’ academic performance?  
  5.1.2 Summary of the findings relating to Research Question 2: What are students’ perceptions of the research placement year as a learning experience?  
  5.1.3 Summary of the findings relating to Research Question 3: How does the research placement year influence students’ career aspirations?  
5.2 Limitations of the study and future directions  
5.3 Impact of the study  

6. REFERENCES  

7. APPENDICES  
Appendix 1: The aims and learning objectives for the research placement year at University X  
Appendix 2: Study participant details  
Appendix 3: Nature and location of research placements in 2013-14  
Appendix 4: Pre-placement questionnaire  
Appendix 5: Post-placement questionnaire  
Appendix 6: Study information sheet  

Word count: 13,027 words
LIST OF FIGURES AND TABLES

Figure 1: The structure of the BSc (Hons.) Biomedical Sciences degree schemes at University X.  
Figure 2: Authentic learning matrix  
Figure 3: Time line of data collection  
Figure 4: Students’ evaluation of their transferable skills before placement  
Figure 5: Perceived changes in transferable skills  
Figure 6: Students’ perceived changed in skill levels  
Figure 7: Attitudes to academic life  
Figure 8: Students’ evaluation of research experience  
Figure 9: Developing identities as scientists  
Figure 10: Influence of the placement on graduate plans  
Figure 11: Overall value of placement  
Figure 12: Word cloud to illustrate positive perceptions of the placement

Table 1: Contribution of marks to final degree outcome  
Table 2: Summative assessment of the placement year  
Table 3: Graduate attributes  
Table 4: Student numbers  
Table 5: Final degree outcomes  
Table 6: Academic performance in the final year  
Table 7: Academic performance in the final year project  
Table 8: Academic performance in Year 2  
Table 9: Academic performance throughout the placement degree scheme  
Table 10: Progression of students on different degree schemes  
Table 11: Placement year performance
LIST OF ABBREVIATIONS, SYMBOLS AND ACCRONYMS

< less than
> more than
2i upper second class degree
2ii lower second class degree
ANOVA Analysis of variance
BERA British Educational Research Association
cf. compare (conferre)
e.g. for example (exempli gratia)
GEM Graduate Entry to Medicine
HEA Higher Education Academy
HEFCE Higher Education Funding Council for England
HESCU Higher Education Careers Service Unit
i.e. that is (id est)
P probability
QAA Quality Assurance Agency for Higher Education
RQF Regulated Qualifications Framework
SD Standard deviation
UK United Kingdom

GLOSSARY OF STATISTICAL TERMS

Students’ paired t-test: used to compare two population means, where observations in one sample can be paired with observations in the other sample

Students’ unpaired t-test: used to compare two population means, where the two samples are independent

Analysis of variance: used to compare differences between two or more means

P-value: calculated probability, used as a measure of the level of significance
1. **INTRODUCTION:**

This project investigated the impact of a research placement (‘sandwich’) year on students’ academic performance, employability skill set and career aspirations. The study focused on undergraduate students enrolled on Biomedical Sciences B.Sc. (Hons.) degree schemes at a research-intensive university. Biomedical sciences are a facet of the life sciences, and include anatomy, physiology and neuroscience. Placement degree schemes offer an optional third year (Regulated Qualifications Framework (RQF) level 5) spent undertaking a scientific research project in an active research laboratory (*Figure 1*). This research placement year is available to all students on all Biomedical Science degree schemes at University X. During the optional placement year, students can spend a period of 9-12 months working in a scientific research organisation, *e.g.* the pharmaceutical/biotechnology industry, a research institute, a university or a hospital. The general aims of the placement include allowing undergraduate students to gain first-hand experience of the principles and practice of bioscience research, as well as enabling them to appreciate the application of their subject in a workplace context and to relate their academic abilities and technical expertise to the needs of an employer. By the end of the placement, students are expected to demonstrate a range of knowledge, skills and attributes appropriate to a biomedical researcher (*Appendix 1*).

*Figure 1: The structure of the BSc (Hons) Biomedical Sciences degree schemes at University X*

1.1 **Research questions**
This study investigated the academic and practical value of the research placement year. This was achieved by assessing the perceived and actual impact of such an authentic learning opportunity, using quantitative and qualitative research methods to address the main research questions. Academic performance data were collected, and students’ opinions were solicited using written questionnaires. The study analysed students’ opinions and academic performance before and after their placement year, to address the following specific research questions:

1. How does the completion of the research placement year influence students’ academic performance?

2. What are students’ perceptions of the research placement year as a learning experience?

3. How does the research placement year influence students’ career aspirations?

1.2 Research rationale

The research placement year represents an opportunity for ‘authentic learning’. Authentic learning has been defined as “learning that is seamlessly integrated or implanted into meaningful, ‘real-life’ situations” (Jonassen et al., 2008, p.5). Learning by experience is not a new concept; such an approach has traditionally underpinned the acquisition of skills through apprenticeships and other workplace mentoring or training schemes and it has become a standard feature of many academic programmes (Kolb, 1984). Experiential learning is particularly suited to the development of specific practical or technical skills and might, therefore, be considered to lie at the heart of scientific training. Benchmarks published by the Quality Assurance Agency for Higher Education (QAA) highlight the pedagogic value of research experience in helping students to achieve graduate outcomes (QAA, 2007). A research
placement year has the potential to enhance the core academic skill set offered by the standard 3-year undergraduate biomedical science degree schemes, by exposing students to the ‘real world’ environment of scientific research and expanding the opportunity for experiential learning. This approach also supports the ethos of ‘research-led’ teaching and learning (Russell Group, 2010).

During their placement, students are expected to undertake ‘real’ research tasks in relation to authentic basic or applied research problems. In the context of this report, the terms ‘real’ and ‘authentic’ are used to distinguish the realm of employment from that of academic study. The limitations of this artificial distinction between the two settings are acknowledged, and the use of these adjectives is not intended to imply that academic tasks are any less valid than employment-related activities. Biomedical sciences students on placement participate in diverse research activities which are ultimately aimed at understanding human health and disease mechanisms, or developing diagnostic, treatment and prevention strategies. The biomedical sector uses contemporary technologies, and biomedical scientists may exploit developments in other disciplines (e.g. chemistry, physics, computer science) by applying them in innovative ways. Joining a research laboratory workplace could give students access to leading-edge scientific equipment and specialist technical support; in comparison, undergraduate teaching resources are more limited in both scale and scope. A recent report commissioned by the UK Government recommends integrated work experience as a means to promote acquisition of general skills and abilities, in concert with development of subject knowledge (Wilson, 2012). An integrated research placement could provide students with opportunities to develop experimental and technical skills that are less likely to be available within the standard 3-year degree course.
1.2.1 Organisation and assessment of the placement degree scheme

The research placement year at University X is designed to offer more than basic work experience; the student should be involved in all aspects of scientific research, including the design and execution of experiments, the analysis and interpretation of the data and the communication of findings. The aim is for the placement student to work with a group of scientists towards a common research goal, but for the student to assume primary responsibility for their own facet of the investigation within the broader research programme. This requires the student to develop and apply general transferable skills (e.g. problem-solving and team-working), which are important markers of employability in the sector. Close observation of the structure of an organisation, and participation in its operation, might also be expected to enhance the student’s general employability skills, however, it is recognised that the majority of students now combine university study with some form of paid employment (Little and Harvey, 2007), which may also assist in developing these skills.

In addition to the authentic learning available to students during their placement, the process of identifying and securing placements itself offers further ‘real-world’ experience. At University X, this process is deliberately designed to be student-led, with academic staff providing support and guidance. All students are eligible to undertake a placement and are encouraged to identify appropriate employers/supervisors. The quality of each placement is assured by careful attention to academic requirements, as well as health and safety considerations and the technical and financial viability of the research. This process guarantees that the foundation for the placement is as secure as possible. Ultimately, a student’s progression into the placement year is dependent on their successful completion of the second year of the degree scheme.
Assessment of students’ performance on work-based placements is challenging for several reasons; templates for assessment of academic performance may not easily transfer to integrated work-based activities and the assessment process is likely to involve external parties. As a consequence, universities operate diverse models which may or may not bear credits towards the final degree (Attwood, 2010). At University X, the student’s performance during the placement year is assessed and contributes 10% to their final degree mark overall (Table 1); there are three assessment components which combine to reflect the academic, technical and professional skills of the student (Table 2).

**Table 1: Contribution of marks to final degree outcome.** The relative contributions of each year of the degree to the overall degree mark at University X.

<table>
<thead>
<tr>
<th>Year of degree</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Research Placement Year</th>
<th>Final Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQF Academic level (UK)</td>
<td>Level 4</td>
<td>Level 5</td>
<td>Level 5</td>
<td>Level 6</td>
</tr>
<tr>
<td>Standard 3-year degree schemes</td>
<td>0%</td>
<td>30%</td>
<td>-</td>
<td>70%</td>
</tr>
<tr>
<td>4-year ‘sandwich’ degree schemes</td>
<td>0%</td>
<td>20%</td>
<td>10%</td>
<td>70%</td>
</tr>
</tbody>
</table>

The majority of the mark from the year is derived from academic tasks, integrated into the workplace, which are assessed using academic marking criteria. Translation of practise-based ‘authentic’ learning to more decontextualised assessment tasks can lead to tension between academia and the workplace (Yorke, 2005), but external (i.e. non-academic) contributions to the assessment process can also generate quality-control issues as external assessors must have similar understanding of assessment criteria and standards (Jisc, 2016). Informal feedback from both students and placement supervisors supports summative assessment of the placement activities at University X.
Table 2: Summative assessment of the placement year. The components of assessment for the placement year at University X (2013-14)

<table>
<thead>
<tr>
<th>Component</th>
<th>Assessor(s)</th>
<th>Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written scientific report</td>
<td>Academic staff</td>
<td>70%</td>
</tr>
<tr>
<td>Oral presentation</td>
<td>Academic staff</td>
<td>20%</td>
</tr>
<tr>
<td>Professional conduct in the workplace</td>
<td>Placement supervisor</td>
<td>10%</td>
</tr>
</tbody>
</table>

During the placement year, University X maintains a close liaison with both the placement student and their research supervisor. Each student is appointed a University tutor who is responsible for ensuring that both student and host institution are content with the progress of the project. The tutor communicates regularly with the student and would usually visit them at their workplace at least once during the year. The placement degree scheme in operation at University X is representative of similar schemes currently offered at other research-intensive universities in the United Kingdom (UK) (e.g. Hejmadi et al., 2011; Naughton and Naughton, 2016).

1.3 Aims of this study:

Professional training year students are required to pay tuition fees during their time on placement, albeit at a substantially reduced rate. Some Biomedical Sciences students are able to secure fully-paid placement positions, often in the pharmaceutical industry, but many students receive no external funding for the ‘sandwich’ year other than standard student loans. The additional year as an undergraduate can therefore represent a significant financial commitment for some students. This study aims to assess the value of the placement year in terms of any academic benefits to the student, as well as any enhancement of general
employability skills. It also examines how early exposure to the research workplace environment might impact on students’ career plans. This information will be useful to undergraduate students evaluating the costs and benefits of undertaking a placement year. Furthermore, the results of this study may inform and improve the design, delivery and assessment of the four year Biomedical Sciences placement degree schemes at University X, and may also be applied to other professional placements degree schemes and other institutions. More generally, this study will contribute to understanding the ways in which universities can work with external institutions to produce science graduates with a full complement of specialist and general employability skills.
2. LITERATURE REVIEW

The life sciences research sector has important economic significance in the UK, a fact that has been recognised by recent government strategies to support this aspect of British research activity (Her Majesty’s (HM) Government, 2011). In 2012, pharmaceutical and medical biotechnology companies employed nearly 170,000 people and generated an annual turnover of approximately £50bn (HM Government, 2012). Commercial application of life sciences research represents only one facet of this sector, though. Life sciences research is also integral to the activities of British universities and national research organisations (e.g. National Institute for Medical Research), as well as the National Health Service, and such research is fundamental to the economic and strategic success of these institutions.

The continued viability of the life sciences sector is dependent upon provision of a suitably skilled graduate workforce. Undergraduate life sciences degree courses have traditionally focused on the development of subject-specific knowledge and understanding, together with the development of general academic skills (e.g. critical analysis, data handling), as the core attributes of their graduates (Cranmer, 2006). In contrast, despite the highly specialised nature of the discipline, employers in the biomedical sector have been shown to value more general employability skills above subject-specific knowledge (McCune, 2009; Saunders and Zuzel, 2010). Employers judge enthusiasm and willingness to learn as the highest priority attributes for potential employees, together with listening skills, attention to detail and oral communication; in contrast, subject knowledge-related traits are given a relatively low priority (Saunders and Zuzel, 2010). This same study reveals that sandwich students’ and graduates’ views of desirable graduate characteristics demonstrated fairly good agreement with the
employers (Table 3). This might be explained by these students’ experiences of the workplace. The work placement alters students’ self-perceptions, such that they are more able to identify themselves within the scientific community of practice (McCune, 2009). It is reasonable to assume that it could be more difficult for standard undergraduates who have not undertaken work experience to develop such a clear understanding of the needs of an employer. Furthermore, work experience is recognised as a key differentiator for gaining employment (High Flyers Research, 2016).

**Table 3: Graduate attributes**, as prioritised by employers (n=59) and sandwich students/recent graduates (n=74). Blue italic font indicates discrepancies between the opinions of students and those of employers (information extracted from a list of 35 attributes, encompassing core skills, personal qualities and subject knowledge; Saunders and Zuzel, 2010).

<table>
<thead>
<tr>
<th>Employer Priority</th>
<th>Attribute</th>
<th>Student Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Enthusiasm / Willingness to learn</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>Questioning / listening</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>Attention to detail</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Oral communication</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>Dependability</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>Integrity</strong></td>
<td><strong>22</strong></td>
</tr>
<tr>
<td>5</td>
<td>Commitment</td>
<td>13</td>
</tr>
<tr>
<td>11</td>
<td>Technical skills</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>Team working</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>Understanding of concepts</td>
<td>7</td>
</tr>
<tr>
<td>11</td>
<td>Application of knowledge</td>
<td>14</td>
</tr>
<tr>
<td>24</td>
<td>Breadth of knowledge</td>
<td>23</td>
</tr>
<tr>
<td>26</td>
<td>Up-to-date with developments in discipline</td>
<td>26</td>
</tr>
</tbody>
</table>

Despite their awareness of the significance of key employability attributes, sandwich students demonstrate a general tendency to overestimate their competency in these areas. Biomedical
sciences students judged themselves to demonstrate greater proficiency in many core skills, personal qualities and subject knowledge, relative to employers’ evaluation of the same attributes (Saunders and Zuzel, 2010). This may reflect an enhanced confidence arising from their authentic learning experiences in the workplace. Indeed, final year bioscience undergraduates highlight the significance of the placement year in their developing identities as scientists (McCune, 2009). They compare their university-based practical class experiences less favourably to the ‘real’ science they undertook during their placement. Interestingly, undergraduate students prioritise the acquisition of technical skills as the most important attribute in enhancing their employability (Saunders and Zuzel, 2010). This aspect of undergraduate training could be most threatened by the physical constraints of increased student numbers and fiscal constraints of altered funding models. As a consequence, opportunities to develop expertise in standard laboratory techniques may be less available to current undergraduates than they were previously, and this may be a source of concern to them. In contrast, employers are less concerned that graduates demonstrate technical expertise (Table 3; Saunders and Zuzel, 2010).

### 2.1 Developing employability through the undergraduate curriculum

Many undergraduate students invest in a university education as the first step to a professional career, despite the fact traditional academic degrees do not necessarily focus on employability (Attwood, 2010). Post-graduate prospects remain good for biomedical science disciplines, although graduate destinations tend to be varied. Recent data concerning the 2013 cohort of graduates from UK universities indicate that 25% of biology-related graduates went on to further study, training or post-graduate research (Higher Education Careers Services Unit
A further 65% of graduates were in full or part-time employment after six months, but the data indicate that only one-third were directly employed in discipline-related activities (HECSU, 2014). This trend suggests that undergraduate bioscience courses are preparing students to enter a variety of career paths, and supports the emerging view that generic employability skills may be as important as subject-specific knowledge in determining opportunities for graduate employment and training (Saunders and Zuzel, 2010). In parallel with this, the university culture has evolved to become more sympathetic to the issue of employability (Attwood, 2010), with increasing emphasis on strategies that ensure broader contextualisation of academic disciplines in the undergraduate curriculum. This paradigm shift may reflect the complex influences of the prevailing market economy on the traditional university ethos (Brown, 2011).

Employers require graduates to have a suitable portfolio of skills to allow them to make meaningful contributions to the work of the organisation from the start of their employment (Wickramasinghe and Perera, 2010). A university education is now expected to provide students with opportunities to develop employability attributes and other life skills in parallel with their academic development (Gunn, Bell and Kafmann, 2010). There is no single definition of employability, but The Higher Education Academy (HEA) acknowledges the prevailing definition as:

“a set of achievements — skills, understandings and personal attributes — that make graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community and the economy.” (Pegg, Waldock, Hendy-Isaac and Lawton, 2012, p.4).

In most institutions, development of employability skills during undergraduate education is now embedded within formative and summative activities that are integral to the degree
programme (e.g. York, 2004); other institutions have developed parallel programmes to promote employability skills in a discipline-independent context (e.g. Baker and Henson, 2010; Craig and McKinney, 2010). In either case, explicit identification of such skills training appears necessary to ensure students recognise this aspect of their undergraduate education (Scott, 2007). Furthermore, students undertaking academic or authentic tasks within the academic setting may not fully realise the ‘real world’ application of such activities (McCune, 2009).

![Authentic learning matrix](adapted from Herrington (1999))

Herrington (1999) proposed a matrix to describe learning opportunities in different contexts (Figure 2). Applying this matrix to the format of bioscience undergraduate degree schemes, it is clear that the majority of learning opportunities fall in the upper left quadrant, i.e. academic tasks completed in an academic setting (e.g. essay writing, practical class reports). Final year projects offer opportunities for undergraduates to participate in more authentic research tasks, although this is still constrained within the academic setting. Students value the final year
project as a means to develop the skills and attributes of scientists (Stefani et al., 1997).

Placements, however, are distinct in taking the student out of the academic setting and into the authentic environment of the workplace (lower right quadrant of the matrix). The integrated research placement therefore lies the intersection between the teaching-learning environment of the university and the research community of practice. In this context, undergraduates participate in authentic tasks that relate directly to the success of the organization and, as a consequence, they experience the dynamic complexity of experiential learning (Klein, 2003).

The early educational theorist John Dewey wrote, “...there is an intimate and necessary relation between the process of actual experience and education.” (Dewey (1938) p.20).

Experiential learning clearly provides an essential link between education and employment, but it also facilitates personal development (Kolb, 1984). Such workplace learning encompasses acquisition of tacit forms of knowledge (i.e. procedural-based knowledge) as well as more abstract, declarative or explicit forms of knowledge (Raelin, 2008). The work placement therefore offers undergraduates opportunities to further their understanding of scientific concepts in concert with the development of mental and physical skills appropriate to the workplace.

Experiential learning opportunities, such as the integrated placement year, have been shown to encourage personal reflection (Aukes et al., 2008); furthermore, reflective practices have been demonstrated to enhance experiential learning (Lachmann et al., 2014). Successful research requires regular reflection, so the placement year could encourage students to develop their reflective practices and to recognise the development of personal attributes and employability skills as an integral aspect of authentic learning.
2.2 Improving academic skills through authentic learning

In addition to the opportunities for personal and professional development discussed above (Section 2.1), it appears that there are academic benefits associated with work placement. Students who have undertaken a placement year as part of their degree tend to achieve better degree outcomes; this observation holds true across a broad range of disciplines, e.g. biomedical science (Gomez, Lush and Clements, 2004); economics (Mandilaras, 2004); psychology (Reddy and Moores, 2006); surveying (Mansfield, 2011). Although this is not the primary aim of the placement year, academic performance is an important determinant of graduate prospects. Recruiters use degree classifications as a way to filter potential employees, so any academic advantage associated with the placement degree scheme may further enhance employment opportunities for these graduates (Bowes and Harvey, 2000). It is not immediately clear why the work placement should influence subsequent academic performance, since the pedagogic value of experiential learning might not be expected to apply directly to more abstract academic tasks. There are several possible explanations for this relationship. Students’ motivation and engagement with their academic studies may be improved as a direct result of the placement experience, or as a consequence of the added maturity conferred by the extra year (Rawlings, White and Stephens, 2005). Alternatively, the placement may give students an opportunity to develop and refine higher-order cognitive skills, i.e. analysis, evaluation and synthesis, as identified in Bloom’s taxonomy (Anderson and Krathwol, 2001). Such higher-order thinking is crucial to success in the final year of the degree, when undergraduates are required to demonstrate complex judgement skills such as critical analysis and problem-solving. These skills are more difficult to teach and learn than lower-order skills like recall, and appear best fostered through practice (Stefani et al., 1997; Todd, Bannister and Clegg, 2004). The research placement routinely exposes students to higher order
thinking tasks in the context of addressing authentic research problems. Furthermore, the relationship between the student and their placement supervisor requires the student to take an active role in their own learning (Stefani et al., 1997) and, therefore, has the potential to enhance the development of deeper learning approaches that are core to attainment of graduate outcomes (Orsmond, Merry and Reiling, 2010). Thus, the placement gives students an opportunity to rehearse final year (RQF Level 6) attributes in advance of their final year and to reflect on their learning; they may subsequently apply this experiential learning to decontextualised academic tasks.

2.3 Sources of information

This review of the literature was based predominantly on comprehensive evidence from peer-reviewed articles published in educational journals over the last decade. Most of these papers were identified and obtained using the search engine ‘Summon’, with additional sources acquired using ‘MetSearch’ and ‘Google Scholar’; a range of search strategies were employed to address different aspects of the study. Since this study was concerned with authentic learning opportunities for undergraduates in Biomedical Science degree schemes, there was a primary focus on quantitative and qualitative studies relating to Biomedical Sciences, but evidence from a wider range of disciplines was also evaluated. Published, peer-reviewed research studies were considered in the broader context of more general sources, e.g. Times Higher Education Supplement, as well as non-peer reviewed ‘grey’ documents, e.g. government papers, learned society reports.
3. RESEARCH METHODOLOGY

3.1 Research approach

A longitudinal case study was undertaken of a single cohort of undergraduate students on three B.Sc. (Hons.) Biomedical Sciences degree schemes at a research-intensive university in the UK. A case study design frame was chosen since it recognises the influence of multiple variables which can be studied analytically and holistically using multiple methods (Stake, 1995). Furthermore, case studies are widely accepted as valuable tools to describe and identify patterns within specific populations (Cohen, Manion and Morrison, 2007) and case studies of undergraduate student cohorts provide a framework for numerous published reports of educational research in the university sector (e.g. Cranmer, 2006; Jones, Green and Higson, 2015). The design of this case study employed a mixed methodological approach; positivist research traditions were applied to interrogate quantitative data sets, and interpretivist practices were used to examine qualitative data. This combined methods approach allowed triangulation of independent findings, which is recognised as a way of reducing bias and upholding the validity and reliability of the results (National Research Council, 2002).

This study investigated the student cohort electing to undertake the four-year placement (‘sandwich’) Biomedical Sciences degree schemes (in Physiology, Neuroscience and Biomedical Science) in 2013-14. All students who met this criterion were included in the study (n=23; 18 females, 5 males); they represented 24% of the full cohort of students on all Biomedical Sciences degree schemes in 2013-14. Specific subject details are included in Appendix 2. The age range of the cohort was 20-26 years at graduation (mode = 21 years) and two of the 23
participants were international students. The general demographic profile of the study cohort was representative of the wider student population on Biomedical Sciences degree schemes during the period of the study (Universities UK, 2014). Neither performance data nor questionnaire responses were separated on the basis of age, gender, ethnicity, socio-economic status or the specific educational backgrounds of individual respondents. Some academic performance data from the participants in this study were compared against those of other students not undertaking the placement year. The three comparator groups comprised two cohorts of students on the standard 3-year Biomedical Sciences degree schemes without the placement year, and one cohort of students on the Biomedical Sciences Graduate Entry to Medicine (GEM) degree scheme (Table 4). All students were required to meet standard entry requirements for the Biomedical Sciences schemes at University X (equivalent of at least three A-levels (minimum grades: A, B, B), of which at least two were science subjects), and all were considered to have access to a common learning experience in the first two years of their undergraduate degree schemes. Entry level qualifications (Higher Education Statistics Agency (HESA) scores) and academic performance in the first year of the degrees were not analysed further, since these have been shown to have little influence on performance in the later years (Gomez, Lush and Clements, 2004). Although this case study is constrained to a unique learning environment, its conclusions may be pertinent across the wider University sector.

Table 4: Student numbers. The number of students completing components of Biomedical Sciences degree schemes in the period of study
3.2 Data collection

Figure 3 shows key points in the timeline of data collection relating to this study. Both qualitative and quantitative methodologies were used to address the three main research questions.

![Timeline of data collection](image)

**Figure 3 Time line of data collection during the period of this study**

3.2.1 Collection and analysis of opinions using questionnaires
Students’ expectations and perceptions of their placement year were investigated using semi-structured questionnaires; this approach was used to address research question 2: *What are students’ perceptions of the research placement year as a learning experience?* and research question 3: *How does the research placement year influence career aspirations?* Questionnaires are widely accepted as valid instruments for collecting information in the field of educational research (Cohen, Manion and Morrison, 2007). Their use is well justified as a way to solicit opinions from undergraduate student populations, as evidenced in the literature (e.g. Bullock, Hejmadi and Lock, 2012). In this study, the use of questionnaires allowed collection of factual information together with exploration of prevalent perceptions and attitudes, while ensuring the process had a high level of standardisation (Sharp, 2009). It was also judged to be the most appropriate way to maximise the number of participants in this study, so that the opinions collected could be considered a valid and reliable representation of the views across the cohort. Furthermore, questionnaires are a valuable way of promoting reflective practices, particularly in relation to authentic learning (Lachmann *et al.*, 2014). In this case study, questionnaires were designed to prompt reflection on both the specialised and general learning opportunities of the placement year, and to promote contemplation of the short and longer-term impact of this experience.

The full cohort of placement students was invited to participate in this aspect of the study, and participation was voluntary. Questionnaires were delivered and completed at informal group meetings and/or via e-mail, at two key points in the study (*Figure 2*). The students’ experiences of securing a research placement and their career ambitions were gathered first before the start of the placements (June 2013); a second questionnaire was used mid-way through the students’ final year (Jan 2015), to collect their reflections on the placement as a learning experience, to conduct a skills audit and to survey changes in their career aspirations.
Data on the nature of the placements (i.e. institution type, location) were also collected (Appendix 3). The full questionnaires are reproduced in the Appendices (Appendix 4, 5).

3.2.1.1 Questionnaire design

The design of both questionnaires included structured questions, as well as open questions; such semi-structured questionnaires allowed collection of quantitative and qualitative information. Individual questions were trialled first with a small number of undergraduate students who were not involved in this study, to ensure that questions were unambiguous and unbiased. Empirical approaches were used to examine the responses to closed questions (Section 3.2.2.1) and interpretivist research methods were applied to the responses to open-ended questions (Section 3.2.2.2).

3.2.2.1a Closed questions: Participants were invited to respond to a series of statements using a Likert rating scale, which is a well-established method of collecting opinions; this approach was chosen since it permits flexibility in responses, while allowing determination of frequency distributions (Cohen, Manion and Morrison, 2011). A 5-point scale was selected to allow for neutral responses, which were judged to be valid in this study, as well as graded bipolar responses; a broader 7-point scale was rejected as such scales can reach the upper limits of reliability (Nunnally and Bernstein, 1994). Graded responses were subsequently collapsed into positive, negative and neutral reactions; this approach is justified for small sample sizes (Matell and Jacoby, 1971) and overcomes potential variability arising from conceptual differences in participants’ interpretation of the scale increments (Cohen, Manion and Morrison, 2011). The frequency distribution of responses was then explored, as a way of assessing the collective opinions of participants; other studies in this field have used a similar methodology (e.g. Hejmadi et al., 2009; Bullock et al., 2009). It is not considered appropriate to use descriptive
statistics on the kind of ordinal data sets generated by the use of the Likert scale (Jameson, 2003), and no other statistical analysis of the distribution of responses was undertaken.

### 3.2.1.1b Open questions:

Open questions allow scope for the participant to provide a richer, more candid response than closed questions (Cohen, Manion and Morrison, 2011). In this study, open questions were designed to facilitate authentic testimony, so the student voice could exemplify key phenomena; this approach is widely used in educational research and has formed the basis of similar studies of undergraduate students (e.g. Marbach-Ad and Arviv-Elyashiv, 2005; Little and Harvey, 2007; Osmond Merry and Reiling, 2010). Participants were invited to supply information relating to their career aspirations, and to express their opinions on the positive and negative aspects of the placement (Appendix 4, 5). Written comments were reviewed according to recognised principles of qualitative data analysis (Cohen, Manion and Morrison, 2011). This approach allowed common themes to emerge, and specific remarks were selected to illustrate the opinions and perceptions of individual respondents. Qualitative data from this aspect of the questionnaire was not codified or categorised, and there was no attempt to aggregate these data, since the study sample did not encompass the full cohort for this aspect of data collection (see Section 3.3). A word cloud visualisation was also created from optimised text using WordItOut software.

### 3.2.2 Collection and analysis of academic performance data

The questionnaire responses were triangulated against quantitative analysis of the full cohort’s academic performance; this addressed research question 1: *How does the completion of the research placement year influence academic performance?* Quantitative data analysis
represents a robust research tool in the positivist tradition (Cohen, Manion and Morrison, 2007). This approach is commonly used to interrogate students’ academic performance data and allows generation of descriptive population statistics for comparisons within and between groups (e.g. Santer, 2010; Brooks and Youngson, 2014; Jones, Green and Higson, 2015; Crawford and Wang, 2016). Performance data were collected following normal examination board moderation procedures in July 2013 (Year 2), December 2014 (placement year) and July 2015 (final year) (Figure 3). Individual summative assessment components of the research placement year were investigated, as well as end-of-year results and overall degree performance. The distribution of each data set was assessed by analysis of variance (ANOVA), then parametric statistical tests (Student’s paired and unpaired t-tests) were applied, as appropriate (Ennos, 2012). Statistical analyses were completed using Excel and ‘R’ software packages. Data sets were summarised using descriptive statistics and values are reported throughout the text as mean + standard deviation (SD); the range of values is also given, where relevant. Significant differences between data sets were accepted when probability (P) values were <0.05 (Ennos, 2012), signifying a likelihood of less than 5% that such differences arose through random chance.

3.3 Sampling process

Quantitative analysis of academic performance data comprised the full cohort of students enrolled on the placement degree schemes during the period of the case study (n=23). However, one student experienced extenuating circumstances which delayed completion of the final year, so the data for this individual are incomplete. In contrast, the respondents to the questionnaires represented a self-selecting sub-group of participants, since completion of questionnaires was voluntary. In this aspect of the study, 16 of the 23 students (70% of the
cohort) completed the first questionnaire and 11/23 (48%) completed the second; 9/23 (39%) completed both questionnaires, 10/23 (44%) completed only one and 6/23 (26%) did not return either questionnaire. These sample sizes were rather smaller than those calculated to be necessary to ensure 95% confidence in the responses, and suggest a margin of error of 15-20% (Krejcie and Morgan, 1970). However, similar response rates are evident in published studies of undergraduate populations (where data are reported, e.g. Saunders and Zuzel (2010)) and are likely to reflect the voluntary nature of the activity and the priorities of the undergraduate population.

3.4 Ethical considerations:

The study was undertaken in accordance with British Education Research Association (BERA) guidelines (BERA, 2011) and with local ethical approval from the host institution. Subject identity was anonymised in all aspects of the study; identifying information was coded (using one letter and four numbers), and coded personal information was kept separate from the data on a secure University computer system. Unique identifier codes were converted to single digits for this report. Quantitative cohort analyses of performance data were undertaken as part of the standard quality assurance process at University X. Descriptive statistics were used to compare aggregated data sets, and no individual marks were identified. Participants were invited to submit completed questionnaires in hard copy or electronically, and responses were also anonymised using the same codes. All participation in the study was voluntary and students gave their informed consent to engage in this study (Appendix 6). Participants were reassured that the results of the study were for educational research purposes only and would
not be used for assessment, or influence academic progress in any way; they were also advised that they were free to withdraw at any point.
4. RESULTS AND ANALYSIS

4.1 Research Question 1: How does completion of the research placement year influence students’ academic performance?

4.1.1 Impact of the placement year on final degree outcome:

The placement year appears to confer clear academic benefits. Students graduating from the research placement (‘sandwich’) degree schemes were 3.5 times more likely to achieve a first class degree, compared to those graduating from the standard 3-year schemes in the same year (Table 5). 55% (12/22) of the students who undertook a placement year attained a first class degree, whereas only 15% (12/78) of those who did not opt for the placement year reached this standard. Furthermore, placement students were four times less likely to receive a lower second class (2\textit{ii}) degree. These finding support earlier evidence for improvements in Neuroscience degree performance at University X (Santer, 2010) and concur with findings relating to Biosciences degrees at other universities (e.g. Gomez, Lush and Clements, 2004; Hejmadi \textit{et al.}, 2012). Graduate recruiters and doctoral studentships usually require a graduate to have achieved an upper second class (2\textit{i}) degree at least, so the academic advantage of the placement degree scheme demonstrated in this study is likely to translate into wider opportunities in the graduate arena (Bowes and Harvey, 2000).

\textit{Table 5: Final degree outcomes.} Profile of final degree classes for students graduating in academic year 2014-2015 from the standard 3-year Biomedical Sciences degree schemes and the 4-year schemes with integrated research placement year.

<table>
<thead>
<tr>
<th>Degree class</th>
<th>Placement degree schemes</th>
<th>Standard degree schemes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( n = 22 )</td>
<td>%</td>
</tr>
<tr>
<td>I</td>
<td>12</td>
<td>54.5</td>
</tr>
<tr>
<td>2\textit{i}</td>
<td>9</td>
<td>40.9</td>
</tr>
<tr>
<td>2\textit{ii}</td>
<td>1</td>
<td>4.5</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
4.1.2 Contribution of individual component marks to the final degree class:

The mean final year mark for students on the placement ‘sandwich’ schemes was significantly higher ($p<0.01$; unpaired t-test) than those for students on the standard degree schemes (Table 6). The mean mark for placement degree students was 68% ($n=22$), whereas the mean marks for students graduating from the standard degrees was at least 5% lower. The overall final year performance of students on the placement scheme was significantly better than the performance of both their entry cohort, graduating in 2014 (mean mark 61% ($n=78$); $p<0.001$, unpaired t-test), and the cohort graduating with them in 2015 (mean mark 63% ($n=94$); $p<0.001$, unpaired t-test). This finding confirms that the superior performance of the placement students is real and is not a result of differences in the scholastic abilities of the different student cohorts. It also corroborates earlier studies of Bioscience placement students which reported a comparable final year mark advantage of approximately 4% (Gomez, Lush and Clements, 2004; Santer, 2010). Studies investigating the influence of a work placement on academic performance in other diverse disciplines demonstrate similar post-placement differentials (e.g. economics (Mandilaras, 2004); psychology (Reddy and Moores, 2006); surveying (Mansfield, 2011)); however, this is not a universal finding (Duignan, 2003; Wilton, 2012, Naughton and Naughton, 2016).

The higher final year mark was evident principally as an improvement in the mark for the research project. Students who had completed the placement year achieved an average project mark of 73% ($n=22$), whereas the average project mark for students on the standard degree schemes was almost 10% lower (Table 7). 15 of the 23 (65%) sandwich scheme students achieved a first class mark for their final year project, and the remaining 8 students (35%) achieved a mark in the $2i$ range. Crawford and Wang (2016) recently reported a similar beneficial effect of the placement on final year project performance. This outcome is not
unexpected, as the research project requires application of a similar combination of technical expertise, deep learning approaches and transferable skills as required by the placement project. The placement year might therefore be expected to have direct pedagogic value in relation to the final year project, and students may recognise this (Stefani et al., 1997). The full scope of the learning experience of the placement year and its influence on final year project performance are considered in more detail below (Section 4.2).

**Table 6: Academic performance in the final year.** Weighted average final year marks for students graduating from the 4-year placement degree schemes in academic year 2014-15, compared to two peers groups: students graduating from the standard 3-year degree schemes in the same year and their entry cohort (graduating 2013-14). P values <0.05 (from unpaired Student’s t-tests) demonstrate differences from the placement degree scheme data set (*).

<table>
<thead>
<tr>
<th>Weighted average final year mark (%)</th>
<th>Mean</th>
<th>±SD</th>
<th>Range</th>
<th>n</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Placement degree scheme (graduating 2015)</td>
<td>68.3</td>
<td>5.0</td>
<td>58.9-76.9</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Standard degree scheme (graduating 2015)</td>
<td>60.9</td>
<td>5.4</td>
<td>49.6-72.5</td>
<td>78</td>
<td>&lt;0.001 *</td>
</tr>
<tr>
<td>Standard degree scheme (graduating 2014)</td>
<td>62.7</td>
<td>7.7</td>
<td>43.9-74.9</td>
<td>94</td>
<td>&lt;0.001 *</td>
</tr>
</tbody>
</table>

**Table 7: Academic performance in the final year project.** Final year project marks for students graduating from the 4-year placement degree schemes in academic year 2014-15, compared to students graduating from the standard 3-year degree schemes in the same year and their entry cohort (graduating 2013-14). P values <0.05 (from unpaired Student’s t-tests) demonstrate significant differences from the placement degree scheme data set (*).

<table>
<thead>
<tr>
<th>Weighted average project mark (%)</th>
<th>Mean</th>
<th>±SD</th>
<th>Range</th>
<th>n</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Placement degree scheme (graduating 2015)</td>
<td>72.7</td>
<td>5.0</td>
<td>64.3-82.0</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Standard degree scheme (graduating 2015)</td>
<td>63.2</td>
<td>6.5</td>
<td>49.3-74.9</td>
<td>78</td>
<td>&lt;0.001 *</td>
</tr>
<tr>
<td>Standard degree scheme (graduating 2014)</td>
<td>63.5</td>
<td>6.4</td>
<td>49.6-72.5</td>
<td>94</td>
<td>&lt;0.001 *</td>
</tr>
</tbody>
</table>

The research project contributes one third of the total mark for the final year at University X, so a significantly higher mark for this component can have a clear impact on the final mark for the year. The observed increase in the weighted average final year mark appears sufficient to
promote transfer across the upper range of the degree classification boundaries, enhancing the final degree outcome for placement students in this study. It has been estimated that more than a quarter of Bioscience placement students could benefit from crossing the threshold to a higher degree class as a result of improved overall performance in the final year (Gomez, Lush and Clements, 2004). A recent survey across a diverse range of academic disciplines, including bioscience, confirmed that placement students are twice as likely to advance across a grade boundary in the final year compared to their non-placement peers (Brooks and Youngson, 2014).

The research placement year is optional and the process by which individuals procure their placements is open and competitive. Applicants are usually judged initially on their academic qualities, with subsequent distinction being made on their aptitude and attitude; as a consequence, the students undertaking placement are likely to be highly motivated individuals who have demonstrated strong academic performances in the first year of their degree. Hence, the students who are successful in securing research placements may not necessarily reflect the range of qualities and attributes apparent in the standard student cohort. The placement students in this study tended to demonstrate better academic performance in the second year of their degree (RQF level 5) compared to their peers on standard degree schemes (Table 8). The average Year 2 performance of students who secured research placement positions was 67% \( (n=23) \), which was significantly higher than the average marks of 60% \( (n=103) \) for the students who did not undertake the placement year and 62% \( (n=126) \) for the combined cohort \( (p<0.05; \text{unpaired t-test}) \). Placement students also reported confidence in their skills and abilities (Section 4.4.4, below). Self-selection of higher-calibre students to undertake placement degree schemes has been documented (Gomez, Lush and Clemens, 2004; Jones,
Green and Higson, 2015; Crawford and Wang, 2016) and the present study confirms that the placement degree scheme cohort demonstrate superior academic performance.

**Table 8: Academic performance in Year 2.** Weighted average Year 2 marks (RQF level 5) for students opting for the placement degree, compared to students on the standard degree scheme and the combined cohort (fail marks excluded from these data). P values <0.05 (from unpaired Student’s t-tests) demonstrate significant differences from the placement degree scheme data set (*).

<table>
<thead>
<tr>
<th>Weighted average Year 2 mark (%)</th>
<th>Mean</th>
<th>±SD</th>
<th>Range</th>
<th>n</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Placement degree scheme</td>
<td>66.8</td>
<td>7.8</td>
<td>45.3-78.2</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Standard degree scheme</td>
<td>60.2</td>
<td>6.9</td>
<td>40.2-75.3</td>
<td>103</td>
<td>&lt;0.001 *</td>
</tr>
<tr>
<td>Combined cohort</td>
<td>61.5</td>
<td>7.5</td>
<td>40.2-78.2</td>
<td>126</td>
<td>&lt;0.001 *</td>
</tr>
</tbody>
</table>

**4.1.3 Academic performance of placement students**

There was no significant improvement in the mean mark for the placement year students in their final year (RQF level 6) compared to Year 2 and, although 14 of 22 students’ marks increased in the final year, a paired t-test revealed no significant differences in the performance of individuals in general (Table 9). This finding was unexpected, since Brooks and Youngson (2014) reported that placement students demonstrate an average improvement of 3% in their final year. However, in the present study, the placement year students’ final year project marks were significantly higher (p<0.01; paired t-test), and the average moved across the degree classification boundary into the first class range (Table 7). The placement year has a strong emphasis on the principles and practice of scientific research, and is likely, therefore, to provide a robust foundation for future research activities, such as the final year project; this is discussed in more detail below (Section 4.2.4).

**Table 9: Academic performance throughout the placement degree scheme.** Placement year students’ academic performance through their degree. P values < 0.05 (from unpaired...
Student’s t-tests) demonstrate significant differences between data sets (* vs Year 2 mark; # vs final year)

<table>
<thead>
<tr>
<th>Weighted average (%)</th>
<th>Mean</th>
<th>±SD</th>
<th>Range</th>
<th>n</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 2 overall</td>
<td>66.8</td>
<td>7.6</td>
<td>46.3-78.2</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Research placement year</td>
<td>67.7</td>
<td>7.2</td>
<td>47.9-83.3</td>
<td>23</td>
<td>0.340</td>
</tr>
<tr>
<td>Final year overall</td>
<td>68.3</td>
<td>4.8</td>
<td>58.9-76.9</td>
<td>22</td>
<td>0.352</td>
</tr>
<tr>
<td>Final Year research project</td>
<td>72.7</td>
<td>5.0</td>
<td>62.7-81.2</td>
<td>22</td>
<td>&lt;0.0002 *#</td>
</tr>
</tbody>
</table>

Although students who undertook a placement year demonstrated superior academic performance in the early years of the degree, it is not the case that all high-achieving students elect to undertake a placement year. A cohort of high-achieving biomedical science students remained on the standard 3-year Biomedical Science degree schemes; these individuals had usually identified a specific vocational career pathway that required further academic study (e.g. medicine, dentistry). In particular, the graduate-entry medicine (GEM) degree scheme at University X is specifically open only to those Biomedical Sciences students with the highest marks in the first year (RQF level 4), and there is a competitive application process for individuals wishing to transfer into this scheme. The cohort of students graduating from the GEM scheme in 2015 achieved a similar Year 2 academic profile to the placement scheme cohort (*Table 10*); this group therefore represented a useful performance-matched comparator group. The average final year performance of the GEM scheme students was also similar to the placement scheme students (*Table 11*); this is not unexpected as Year2 (RQF Level 5) performance has been shown to be a positive predictor for final year (RQF level 6) performance (Gomez, Lush and Clements, 2004). However, the proportion of GEM students achieving a first class degree was lower (5/13 (38%) *cf.* 12/22 (55%)) and the mean mark for their final year project was also significantly lower than that of the placement students in the same year (69%
These data support the hypothesis that good performance in the final year research project is a major influence on attainment of a first class degree, and that the authentic learning experience of the placement year, rather than the prior academic performance of the individual student, is the salient factor. One other study has recently accounted for the potential academic superiority of students who undertake a placement year, and has also demonstrated a real advantage to these students (Jones, Green and Higson, 2015).

**Table 10: Progression of students on different degree schemes.** Weighted average marks for students on the placement degree schemes \((n=22)\) and the Graduate Entry to Medicine (GEM) degree scheme \((n=13)\). Student’s unpaired t-tests were used to generate p-values; significant differences between data sets from placement and GEM schemes were accepted when \(p<0.05\) (*).

<table>
<thead>
<tr>
<th></th>
<th>Placement schemes</th>
<th>GEM schema</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weighted average (％)</strong></td>
<td><strong>mean ±SD</strong></td>
<td><strong>mean ±SD</strong></td>
</tr>
<tr>
<td>Year 2</td>
<td>66.8 ±7.6</td>
<td>66.2 ±4.6</td>
</tr>
<tr>
<td>Final Year</td>
<td>68.3 ±4.8</td>
<td>67.6 ±4.0</td>
</tr>
<tr>
<td>Final Year research project</td>
<td>72.7 ±5.0</td>
<td>68.7 ±4.4</td>
</tr>
</tbody>
</table>

**4.1.4. Performance in the placement year**

The placement year is assessed and contributes 10% to the overall mark for the Biomedical Sciences degree. The average mark for students in their placement year was not significantly different from those in their second and final years (**Table 9**). Analysis of the individual component marks for the placement year, however, revealed clear differences in mean marks for the three elements of the assessment (**Table 11**). The mean written component mark was 65% \((n=23)\) and the mean oral assessment mark was 70% \((n=23)\). There was a marginal
difference between these two data sets (p=0.049). The superior academic performance of placement students in summative assessment of the final year project, which included similar written and oral components (Table 10) suggests that these students benefitted from the experience of the assessment process as a rehearsal for the final year. Furthermore, the placement year provides students with opportunities to develop the complex cognitive skills associated with success in the final year project (James, 1998; Parkinson, et al., 2011). The students in this study reported feeling better prepared for their final year research project after completing the placement year (Section 4.2.4, below), which suggests they appreciate the academic value of the authentic learning experience.

Table 11: Placemen...performance. Summative assessment of placement year performance (n=23). P values of <0.05 (F-test followed by ANOVA) indicate differences between data sets (* vs oral communication; # vs written report)

<table>
<thead>
<tr>
<th>Mark (%)</th>
<th>Mean</th>
<th>±SD</th>
<th>Range</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written report</td>
<td>65.4</td>
<td>8.8</td>
<td>37.7-84.0</td>
<td></td>
</tr>
<tr>
<td>Oral communication</td>
<td>69.7</td>
<td>6.3</td>
<td>57.7-82.1</td>
<td>=0.049 #</td>
</tr>
<tr>
<td>Workplace assessment</td>
<td>80.9</td>
<td>9.9</td>
<td>62.8-95.0</td>
<td>&lt;0.0001 *#</td>
</tr>
</tbody>
</table>

4.3 Research Question 2: What are students’ perceptions of the research placement year as a learning experience?

4.2.1 The placement year student as ‘employee’

The placement supervisors assessed their student’s work place performance and professional conduct according to objective criteria which included consideration of the students’ employability attributes, interpersonal skills, technical proficiency and research competence. This aspect of the assessment generated an average mark of 81% (n=23), which was significantly higher than the marks for either the written report or the oral assessment
(P<0.001, ANOVA; Table 11). For the majority of students (20/23; 87%), the workplace performance mark was their highest individual component mark for the placement year assessment; furthermore, for 19/23 (83%) students, the mark for this component was in the first class range. Although this aspect of the assessment represents a small proportion of the mark overall, it is important because it provides an independent evaluation of the student’s potential as an employee. Clearly, most students were judged to have performed exceptionally well in the research workplace; by the end of their placement, they were considered to have developed the portfolio of characteristics expected of an employee. Completing a placement year has been documented to translate into increased job opportunities for graduates (Bowes and Harvey, 2000). Employers are increasingly likely to seek graduates who have appropriate work experience (High Flyer Research, 2016) and the placement provides evidence of competence in this area. Furthermore, Baker and Henson (2010) revealed that development of general employability skills in parallel with the development of subject-specific knowledge and understanding could enhance academic performance; this would also be expected to further enhance employment prospects.

4.2.2 Skills and attributes of the placement year student

When asked to assess their relative expertise across a range of work skills and attributes, the placement students in this study tended to judge themselves to be at or above average, even before the start of their placements (Figure 4). Placement students have been shown previously to overestimate their abilities in the absence of objective criteria (Saunders and Zuzel, 2010); however, a confident attitude may have been beneficial to these students in the competitive process of securing a research placement. The participants in this study were particularly assured in the standards of their software skills (word processing, graph plotting) as well as their numeracy skills; this finding supports similar perceptions in Business students
(Rosenberg, Heimler and Morote, 2012). This suggests that the placement students recognised the opportunities to develop transferable skills that were embedded within the standard undergraduate curriculum, although a previous study suggested that this was not the case (Scott, 2005). Interestingly, there were only two areas in which some respondents appeared less secure; 4 of 11 judged their presentation skills to be lower than expected and 5/11 ranked their networking skills as below average.

**Figure 4: Students’ evaluation of their transferable skills before placement.** Questionnaire responses showing participants’ self-assessment of their own transferable skills and key employability attributes prior to the placement year (n=15)
Experiential learning opportunities, such as the integrated placement year, have been shown to encourage personal reflection (Aukes et al., 2008); this may promote appreciation of cognitive, professional and personal developments. Following their placement year, study participants felt more confident in their abilities across all of the transferable skills and employability attributes (Figure 5). All 11 respondents thought that their ability to give presentations and speak in front of groups of people had improved, although only 4/11 had judged themselves to be lacking before their placement (Figure 4). All but one respondent felt more confident about their time-management skills following the placement (Figure 5), despite the fact that the majority (10/15 respondents) considered themselves to demonstrate ‘above average’ ability in this area before their placement began. Effective public speaking and time management have both been identified by bioscience employers as a key employee attributes (Saunders and Zuzel, 2010) and the placement clearly has an empowering influence in these areas.
Students’ perceptions of their career management skills were also enhanced as a consequence of the placement (Figure 5). Undertaking a research placement away from the undergraduate environment is likely to expose students to a broader spectrum of the scientific population, and to facilitate their integration into the wider scientific community. 8 out of 11 respondents recognised that their networking skills had been enriched by their placement experience and this was also reflected in their free comments. e.g.

“…[My placement] provided a valuable opportunity to network and meet real leaders in their field of expertise.”[participant 5]

“Networking and making contacts with people in jobs that potentially will be valuable to know was of great benefit” [participant 20]

“Good networking opportunities; met [people] while working in labs [who] gave me an insight into life after university” [participant 7]

In the few cases where an individual expressed reduced confidence in their skills as a result of their placement, this is more likely to represent an increased awareness of the standards required, rather than a loss of that skill, since undergraduates’ inflated views of their abilities has been documented (Saunders and Zuzel, 2010).

Nine individuals completed both questionnaires, which allowed direct comparison of the impact of the placement experience. The majority of these students recognised an improvement across the range of skills audited (Table 6), which further supports the general observations from the full cohort.
Several (5/23) students undertook research placements outside the UK. This cultural aspect was a major feature for one student [participant 18], who highlighted “…[the] opportunity to live in another country, travel and learn another language” as a positive experience of the placement year. International placements clearly offer additional learning opportunities and, furthermore, also support one of the key strategic aims of University X.

Literacy skills are key employability attributes in the biosciences sector, with bioscience employers rating ‘written communication’ and ‘information retrieval/analysis’ above other core skills, including numeracy (Saunders and Zuzel, 2010). Bioscience students recognise the importance of good literacy skills (Jones, 2011) and most respondents in the present study judged themselves to demonstrate average writing ability in advance of their placement (Figure 5). In contrast, diagnostic tests in the early years at university indicate that the writing skills of the undergraduate biosciences student population are weak (Jones, 2011); furthermore, life science undergraduates have been reported to lack scholarly scientific literacy (Marbach-Ad...
and Arviv-Elyshiv, 2005). The confidence demonstrated by respondents in the present study may reflect the academic superiority of this cohort (Tables 5, 6, & 8), although assessment strategies commonly used in the early years of undergraduate science degrees (e.g. short or structured answer questions) do not necessarily require demonstration of advanced writing skills.

The majority of respondents (8/11) recognised that they had become more proficient in navigating and reading the literature as a result of their placement experience and 9/11 felt that their writing/reporting skills had improved (Figure 5). This reported improvement could reflect recognition of the specialised nature of the scientific literature. One respondent acknowledged that “... I’m better at reading and finding relevant papers now, and I feel more confident in scientific writing” [participant 4]. Regular reading and writing tasks have been shown to improve science students’ academic literacy (Parkinson et al., 2011). These tasks are integral components of research activity, so the research placement offers students an opportunity to develop and rehearse these skills at an earlier stage of their undergraduate degree. Scientific literacy and analytical skills are associated with the deeper learning approaches at the core of final year study, and of the final year research project in particular (Stefani et al., 1997; Todd, Bannister and Clegg, 2004; Todd, Smith and Bannister 2006). The development of these skills is likely to contribute to the superior final year project marks for students on the placement degree schemes (Table 10; Section 4.1.3, below).

4.2.3 Returning to university

Following their placement, the majority of students (6/11 respondents) indicated that they felt generally better prepared for the final year of their degree (Figure 7). This confidence, coupled with improved skills and deeper learning approaches developed through experience, might lead
to accumulation of marginal gains across the range of final year activities, which could contribute to the improved academic performance of these students (Section 4.1.3).

Furthermore, students have reported increased willingness to engage with their studies as a consequence of work experience (Little and Harvey, 2007; McCune, 2009); indeed the kinds of active learning tasks associated with the placement have been suggested to promote life-long learning behaviours (Kuhnigh et al., 2010). Comments from participants in the present study support the proposal that placements students are primed and motivated, as a consequence of their exposure to the professional environment (Mandilaras, 2004). Placement students have also been reported to demonstrate higher levels of self-esteem and better coping strategies (Purdie et al., 2011); these personal attributes are also likely to promote academic success.

Student opinion was divided when asked to consider how prepared they felt about returning to student life and the academic environment (Figure 7). Half of the respondents (5/11) felt primed to return to university and were empowered by the specific and transferable skills they had developed during the placement year. Other respondents (5/11) felt unprepared for the transition back to university. There are a number of possible explanations for this. Placement students are usually treated as ‘employees’, and some even receive a salary during their placement year, so the return to student life may be perceived as a retrograde step. Alternatively, concern about re-establishing patterns of work could contribute to anxiety, since reluctance to disturb study habits has been reported as a reason why students do not opt for a placement year (Bullock, Hejmadi and Lock, 2012); individuals can also be apprehensive about re-establishing their student identities (Auburn, 2007). All placement students were invited to attend a residential retreat just prior to the start of the final year, which was designed to support the students’ transition back to university life and to address these concerns; not all
participants in this study were able to attend the retreat, which may explain the polarised response to this question.

“By the end of my placement year, I consider that I was...”

4.2.4 Research placement and the final year project

Analysis of academic performance data revealed that students who had completed a research placement were more likely to achieve a significantly higher mark for their final year research project, compared to their peers who had not (Section 4.1.3, above). Questionnaire responses disclosed that the majority of study participants (10/11) felt better prepared for their final year research project as a consequence of their placement (Figure 7). One statement, that the placement year “really helped when I came to do my final year project” [participant 22], acknowledged the direct relationship between these two components of the degree. The placement year is likely to enhance the development of a broad spectrum of skills relating to undergraduate Biosciences projects, including transition from ‘tutor-led’ learning to independent study (Orsmond, Merry and Reiling, 2004). This transition is accepted as priority
of a university education and is usually facilitated by the final year research project, which requires deep learning approaches (Todd, Bannister and Clegg, 2004; Todd, Smith and Bannister 2006). The research placement year also requires students to build on the foundation of lower-order skills to develop independent learning characteristics and practice higher order cognitive skills, so this earlier exposure may facilitate placement students’ earlier acquisition of graduate attributes. Furthermore, Stefani et al. (1997) reported that second- and final-year undergraduates have different conceptions of the skills inherent in the final year project, so the placement may be helpful in adjusting students’ attitudes and understanding of research in advance of the final year project.

Bioscience students strongly perceive the placement as a means of gaining experience in discipline-specific research techniques (Hejmadi et al., 2012). However, acquisition of technical skills is valued more by students than by their potential employers (Saunders and Zuzel, 2010); this suggests that employers perceive technical development as an integral part of job training. The respondents all reported gaining experience and developing expertise across a range of specialist experimental techniques (Figure 8); such expansion of the students’ practical skills portfolio is separate from, but complementary to, the enhancement of their academic and transferable skills discussed above (Sections 4.1.3, 4.2.2, 4.2.3). One respondent in this study [participant 9] reflected that the main positive experience of the placement had been “learning all the practical skills that helped me so much during my final year project”. By developing competence in specialist research methodologies, students are more likely to enter their final year with confidence in their technical abilities; this could confer an advantage over students who have progressed directly to the final year of their degree, and could contribute to the superior performance of placement students in the final year project (Table 10). Practical experience of specialist research techniques would also aid understanding of published
research data; this is likely to facilitate critical analysis of such evidence which could also contribute to success in the research project.

**Figure 8: Students’ evaluation of research experience.** Participants’ development of specialist biomedical research techniques while on placement (n=11). **Panel A** shows the range of techniques reported by participants, and **Panel B** summarises the level and degree of proficiency testified for all techniques. Individual students reported experience in multiple techniques.

4.4 **Research Question 3: How does the research placement year influence students’ career aspirations?**

4.3.1 **The placement year student as ‘scientist’**

The placement year appeared to help students to contextualise their academic study and to realise fully the work of scientists; it also consolidated opinions about their future careers. All 11 students who completed the post-placement questionnaire agreed that their placement afforded them a better understanding of what it means to be a scientist (Fig 9); developing such insight is recognised as an important element of the research placement experience (Hunter, Laursen and Seymour, 2007). Furthermore, 6/11 respondents identified themselves as “real”
scientists; this represents these individuals’ acknowledgement of their own status within the scientific community of practice, as well as their confidence in their ability, which is similar to previous reports (McCune, 2009; Purdie et al., 2011). Most (9/11) respondents also felt they better appreciated the application of their academic subject to the research workplace (Figure 9). This contextualisation could contribute to reports of students’ improved engagement with their academic studies on return to university (Little and Harvey, 2007; McCune, 2009).

Figure 9: Developing identities as scientists. Participants’ responses to statements regarding the impact of the placement year on their ability to contextualise their academic study (n=11)

Several of the participants in this study were recognised to have made major contributions to their research area during their placement. At least six (26%) of the placement students reported contributing to conference abstracts or papers submitted/accepted for publication (by March 2015). This outcome is a testament to the quality of these students’ work and their performance as members of the research team; such material achievements are likely to help endorse the students’ developing identities as biomedical scientists, as well as improve their graduate prospects. The most successful placements could be considered to be symbiotic
relationships, where both parties benefit from the interaction. The published contributions reported by participants in this study demonstrate that placement students can be productive members of staff, generating useful data, such that their presence in the workforce has an intellectual and/or a financial value.

4.3.2 Post-graduate employment and training

This study revealed that the immersive research experience provided during the placement year appeared to clarify students’ career aspirations. The vocational relevance of the experience is an important factor in students’ decision to undertake a research placement (McCune, 2009); before they started their placements, 6 of the 17 respondents indicated that they were intending to pursue a career in research and 11/17 expressed uncertainty. The placement year was cited as a crucial factor in informing the decision for those who were uncertain (8/11 responses). Comments written after the placement demonstrated that exposure to the ‘real’ research environment had given individuals valuable insights and helped to consolidate their career goals. e.g.:

“[The placement year] confirmed my career decision … and showed me that I would be most fulfilled in a research role” [participant 15]

“Before my [placement], I was unsure about what I wanted to do after uni; my [placement] experience definitely confirmed that I want to do a PhD” [participant 9]

“[My placement has] shown me that to work in the scientific sector you need a PhD … therefore, that is more than likely what I shall pursue next.” [participant 5]

However, for some, the placement experience had exposed negative aspects that ruled out research as a career path:

Seeing ... the pressures that scientists are under to publish ... has taken a lot of the pleasure out of science for me.” [participant 18]
“I was fairly confident that I did not want to enter a career in research and carrying out my [placement] confirmed this. I realised I wanted … more job security...” [participant 21]

Following completion of their placements, most respondents had a clearer idea about their career trajectory. Similar numbers of respondents appeared to have decided definitely for or against a career in research and only one respondent remained undecided. This is a positive outcome, since it suggests that the placement allowed undergraduates to make informed decisions about their future; those choosing a research career had an opportunity to develop a better understanding of the associated demands and rewards in advance of committing to a post, and those deciding against a research career often cited an alternative, allied career to which they had been exposed during their placement. e.g.:

“[My placement] provided me with the insight that I preferred the clinical aspects of research and [I have] decided to pursue a career in medicine” [participant 7]

“[I am] considering a career in scientific/medical editing, or in science policy” [participant 18]

Other comments revealed the emerging theme that the workplace environment had been generally helpful in career deliberations:

“IT was really good experience at shaping what I do or don’t want to do after uni[versity]” [participant 4]

“The main positive...was realising what I do and don’t want from a career and this has helped me make informed decisions on what I want to do in the future” [participant 21]

“[I am] more aware of potential options” [participant 16]
Overall, participants in this study acknowledged a more informed career strategy, which supports previous evidence that students themselves value placements as a means of enabling career choices (Walmsley, Thomas and Jameson, 2006).

The placement year also gave most students more confidence about the process of applying for a job or further training (Figure 10), which confirms earlier suggestions that placements allow students to be more assured in their attitude to graduate applications (Branine, 2008; Bullock et al., 2009). This could be explained generally by the increased confidence and maturity of these students (Rawlings, White and Stephens, 2005), or specifically because these students had gained from the authentic learning experience of securing placement positions. In addition, the study participants recognised the relevance of their work experience and their comments highlighted their perceptions that the placement conferred advantages in the graduate job market. e.g.:

“Really good to have on your CV as it is difficult to find time to get [relevant] work experience whilst in university” [participant 22]

“More to talk about when applying for jobs” [participant 21]

These comments support the view that work placements are a perceived by students as a key differentiator in graduate recruitment (Hejmadi et al., 2012).

Despite the observed increase in confidence associated with completing the placement, by the time of the questionnaire (mid-way through their final year), many (7/11) study participants had not yet decided their next step after graduation (Figure 10). Half of the respondents (5/11) indicated that they were likely to undertake further study of some sort; the nature of this study was not explored further, although free comments suggested that it was commonly doctorate study. A study of Bioscience students who took research placements between 2002 and 2004
showed that the majority intended to continue on to further study in the sciences or work in scientific research of some kind (McCune, 2009). This outcome is not so clearly evident in the present study, which may reflect economic influences on the student experience or the research climate over the last decade.

Figure 10: Influence of the placement on graduate plans. Participants’ responses to statements regarding the impact of the placement year on their career plans (n=11)

4.3.3 Students’ overall evaluation of their placement experience

The post-placement questionnaire gave students an opportunity to reflect on and evaluate their placement experiences. All 11 students who completed this questionnaire agreed that their placements were valuable in giving them exposure to the scientific environment and developing employability skills (Figure 11). All respondents also gave a positive evaluation of the overall personal experience of the placement year, and none indicated that they regretted undertaking their placement (Figure 11).
Figure 11: Overall value of placement

Participants’ responses to statements regarding their perceptions of the overall value of their placement year ($n=11$)

Participants were also invited to comment specifically on any positive perceptions of their placement; dominant themes included the acquisition of relevant work experience, the opportunities for networking and the development of a deeper understanding of the relationship between authentic research and academic life (Figure 12). One participant summarised their experience of the placement year as follows:

“A thoroughly enjoyable year where I feel I learned a huge amount, demonstrated what it is like to complete “real science” and enhanced my future job prospects” [participant 5]

This general affirmation of the placement year is supported by evidence from other biomedical science placement degrees (Hejmadi et al., 2012) as well as diverse disciplines (Blackwell et al., 2001; Neill and Mulholland, 2003). The positive outcome is welcome, not least because of the additional financial burden associated with the placement year (in this study, only 2/23 students secured a fully paid placement position). The costs of undertaking a placement year
(and the associated fees, in particular) are commonly cited as a disincentive to uptake of the placement year (Towl and Senior, 2010).

Figure 12: Word cloud to illustrate positive perceptions of the placement. Word cloud generated from participant’s free text comments; text size is directly proportional to the frequency of specific words in comments from all participants (n=11)

In light of all respondents’ obvious endorsement of the placement year, it was surprising that two individuals in this study failed to rate their placement year as a positive experience overall. In one case, this was explained as a result of “unfortunate circumstances” [participant 8] unrelated to the placement and, in the other, it was due to dissatisfaction with the research project. All participants in this study were invited to report negative aspects of their placement year. In general, these were associated with external factors (e.g. delays in receiving samples) or with the workplace environment (e.g. research team composition, local management structure); only one of the respondents indicated that the nature or pattern of their placement
work had been significantly different to their expectations at the outset. This feedback suggests that the application and approval process was successful in preparing students to undertake their specific research placements. A clear understanding of the integrated architecture of the placement within the context of the degree appears essential to facilitate such positive outcomes (Duignan, 2003). The majority of students reflected on their research placement as valuable and enjoyable experience overall, and perceived wide-ranging benefits from the additional year of their degree course.
5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Key findings

This study is unique in combining analysis of academic performance data with students’ reflections on their placement experience. Triangulation of quantitative and qualitative evidence demonstrated academic, professional and personal benefits to students undertaking integrated research placements; work placements less closely aligned to the academic discipline do not appear to provide the same wealth of benefits (Bullock, Hejmadi and Lock, 2012; Naughton and Naughton, 2016). This study is also distinctive in comparing the academic performance of placement students with an ability-matched control group of their peers; although both sets of students achieve ‘good’ degrees, this study reveals specific advantages, relating to the final year project in particular, that are associated with completion of the research placement year. The actual benefits of the placement year correlate well with students’ perceptions of its value.

5.1.1 Summary of the findings relating to Research Question 1: How does completion of the research placement year influence students’ academic performance?

This study demonstrates the immediate benefits of exposure to the principles and practice of research within the authentic research environment. Material advantages of the placement year included improved academic performance, particularly in the final year research project, leading to achievement of a higher class of degree. The findings of this study support the pedagogic value of the placement in advancing students along the learning continuum.
5.1.2 Summary of the findings relating to Research Question 2: *What are students’ perceptions of the research placement year as a learning experience?*

The results of this study show that placement students appreciate the direct relevance of their authentic learning experience and are able subsequently to apply the knowledge and skills gained in the workplace to decontextualised tasks in the university environment. These students value the learning opportunities offered by the research placement year and, as a result, are better able to recognise and evidence their skills and attributes. Furthermore, students realise the comprehensive pedagogic value of the placement in developing their portfolio of specialist research expertise, in the concert with their general academic skills and employability attributes.

5.1.3 Summary of the findings relating to Research Question 3: *How does the research placement year influence students’ career aspirations?*

This study demonstrates that placement students feel better positioned to apply for jobs and more confident about the application process; these students also reveal better insights into the career options available to them after graduation. The study upholds the concept that the immersive experience of the placement allows undergraduates to develop their identities as scientists and to consolidate their career objectives (McCune, 2009).

5.2 Limitations of the study and future directions:

This study identifies patterns in the student cohort which confirm the real and perceived pedagogic value of the research placement year; there is, however, no attempt to make an explicit correlation between specific individuals’ reflections on the placement year and these individuals’ academic performance. Since all data are coded, future studies could examine these data sets further by comparing the questionnaire responses from individual study
participants with their individual academic performance data. This could reveal greater insights into the impact of integrated experiential learning opportunities.

The focus of this study was on the students who completed the research placement year. It would have been useful to solicit the views of students who did not elect to take a placement or who were unsuccessful in securing a placement. This would allow better understanding of the internal and external factors influencing students’ choices.

The placement cohort in this case study was predominantly female. Although there is evidence that female students may outperform male counterparts in the attainment of higher class degrees (Higher Education Funding Council for England, 2014), this is unlikely to be a complicating influence in the present study, as the gender balance was similar in both the standard 3-year and 4-year placement degree schemes and reflects the current gender balance in the wider biosciences undergraduate population in the UK (Universities UK, 2014).

The limited time-scale of this case study prevented collection of participants’ first job/training destinations after graduation. However, cohort data were collected recently as part of the national ‘Destination of Leavers from Higher Education’ (DLHE) survey for 2014-15 graduates. Following release of these data in July 2016, it is proposed that the current study will be extended to review actual career choices following graduation from the Biomedical Sciences placement degree schemes. The superior academic performance and enhanced employability skill set of graduates from placement degree schemes could be expected to provide extended career benefits (Brooks and Youngson, 2014). Longer-term follow up of the participants in this study would reveal the impact of the placement degree over the working lifetime.
The context of this case study is limited to a single cohort of students at a single institution and, therefore, it does not address any possible variations in the career aspirations of different student cohorts or changes in the availability of placement opportunities. The study could be resumed in future to include additional student cohorts, in order to confirm the reliability of these preliminary findings.

### 5.3 Impact of the study

The results of this study will be valuable to all stakeholders in the four-year Biomedical Sciences placement degree schemes at University X. They will be used to inform and improve the design, delivery and assessment of these schemes. The specific impact of the study has several facets:

- In future, the insights and empirical data generated by this study will be shared directly with undergraduates, to allow them to make more informed choices about participation in the placement degree schemes. A report of these findings will also be shared with placement coordinators and personal tutors, and other individuals who support students in their decision processes.

- The results of this study will also form an integral component of the upcoming Periodic Review of undergraduate teaching in the School of Biosciences at University X. The research placement degree scheme has been identified as one of the specific areas of focus for this review and changes to the scope and assessment of the research placement degree schemes are currently under consideration. The results of this study will inform decisions on expanding the nature of the placements to reflect the broader application of biomedical
science in the workplace (e.g. patent law, scientific communication); they will also contribute to discussions on modification of the assessment process to better reflect ‘real world’ tasks and achievements.

- As a result of this study, a mechanism to embed more structured reflective practice into the placement year will be established. At present, students are required to reflect on their experiences only at the end of the year, but informal feedback stimulated by participation in this study suggested that students would value a more systematic approach throughout their placement. As a consequence, a structured reflective log will be introduced in 2016-17, which will allow students to record contemporaneous reflections on their developing skills and attributes. Since frequent opportunities for structured reflection have been demonstrated to have a positive impact on students’ experiential learning (Lachmann et al., 2014), this could be expected to further enhance the pedagogic value of the placement year.

- Evidence from this study will be used to support a formal recommendation to investigate ways to maintain and promote uptake into the placement degree scheme. In the UK, the numbers of students studying on placement degree schemes are lower than in other countries (Little and Harvey, 2007). Opportunities to develop the placement scheme at University X will be considered in the light of the increased academic and administrative burden of greater student numbers, as well as external threats to the scheme e.g. reduced availability of paid placements.

Although this is a relatively small-scale study, it might be appropriate to generalise the findings to work placements degree schemes in other disciplines at University X, as well as across the
wider context of the university sector. Ultimately, this study contributes to understanding the ways in which universities can integrate experiential learning opportunities into the undergraduate curriculum and exploit the pedagogic value of work placements to produce superior graduates who demonstrate essential employability attributes and can make immediate and meaningful contributions to the workplace.
6. REFERENCES


James, P. (1998) ‘Progressive development of deep learning skills through undergraduate and post-graduate dissertations’, Educational Studies, 24(1); pp. 95-105


Orsmond, P., Merry, S. and Reiling, K. (2004) ‘Undergraduate project work: can directed tutor support enhance skills development?’, *Assessment and Evaluation in Higher Education*, **29**(5); pp. 625-642


Wickramasinghe, V. and Perera, L. (2010) ‘Graduates’, university lecturers' and employers’ perceptions towards employability skills’ *Education + Training* 52(3); 226-244


### Aims - The aims of the research placement year are:

- to gain first hand experience of the technical and intellectual processes that underlie research in the biosciences.
- to appreciate the application of academic knowledge to real problems and to relate academic and technical skills to the needs of an employer.
- to encourage the acquisition of new technical skills and experience.
- to develop the ability to organise and plan work efficiently and to co-operate effectively with others.
- to promote maturity and encourage a professional attitude to work.
- to develop an ability to review, interpret, analyse and evaluate published information and data.
- to develop written and oral communication skills.

### Learning Objectives - On completion of the research placement year, a student should be able to do the following:

#### a. Knowledge and Understanding:
- Know and understand the methodologies used in a particular field of work.
- Demonstrate knowledge of the most relevant literature to their field of research.
- Be aware of and critically appreciate a research topic within a particular research area.

#### b. Intellectual Skills:
- Interpret, analyse and critically evaluate literature and/or primary data.
- Discuss and develop ideas in a logical and direct way.

#### c. Discipline Specific (including practical) Skills:
- Understand methodologies, their applications and use in approaches to scholarship in the placement area under review.

#### d. Transferable Skills
- Generate and communicate ideas in science, both orally and in writing.
- Produce a focussed report in an appropriate format.
- Manage time efficiently.
- Show enhanced word processing and graphic skills.
- Use, effectively, literature searching facilities.
- Work effectively with others in a mature and professional way.
Appendix 2: Study participant details. The profiles of the research placement student cohort in 2013-14 (n=23)

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Degree scheme</th>
<th>M/F</th>
<th>Age at graduation</th>
<th>Home student ?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Biomedical Science</td>
<td>F</td>
<td>21</td>
<td>Y</td>
</tr>
<tr>
<td>2</td>
<td>Biomedical Science</td>
<td>M</td>
<td>21</td>
<td>Y</td>
</tr>
<tr>
<td>3</td>
<td>Biomedical Science</td>
<td>M</td>
<td>21</td>
<td>Y</td>
</tr>
<tr>
<td>4</td>
<td>Biomedical Science</td>
<td>F</td>
<td>21</td>
<td>Y</td>
</tr>
<tr>
<td>5</td>
<td>Biomedical Science</td>
<td>M</td>
<td>21</td>
<td>Y</td>
</tr>
<tr>
<td>6</td>
<td>Neuroscience</td>
<td>F</td>
<td>23</td>
<td>Y</td>
</tr>
<tr>
<td>7</td>
<td>Biomedical Science</td>
<td>F</td>
<td>21</td>
<td>Y</td>
</tr>
<tr>
<td>8</td>
<td>Neuroscience</td>
<td>F</td>
<td>22</td>
<td>Y</td>
</tr>
<tr>
<td>9</td>
<td>Biomedical Science</td>
<td>F</td>
<td>23</td>
<td>Y</td>
</tr>
<tr>
<td>10</td>
<td>Physiology</td>
<td>F</td>
<td>21</td>
<td>Y</td>
</tr>
<tr>
<td>11</td>
<td>Neuroscience</td>
<td>M</td>
<td>21</td>
<td>Y</td>
</tr>
<tr>
<td>12</td>
<td>Biomedical Science</td>
<td>F</td>
<td>22</td>
<td>Y</td>
</tr>
<tr>
<td>13</td>
<td>Biomedical Science</td>
<td>F</td>
<td>21</td>
<td>N</td>
</tr>
<tr>
<td>14</td>
<td>Neuroscience</td>
<td>F</td>
<td>21</td>
<td>Y</td>
</tr>
<tr>
<td>15</td>
<td>Physiology</td>
<td>F</td>
<td>26</td>
<td>N</td>
</tr>
<tr>
<td>16</td>
<td>Neuroscience</td>
<td>F</td>
<td>22</td>
<td>Y</td>
</tr>
<tr>
<td>17</td>
<td>Biomedical Science</td>
<td>F</td>
<td>20</td>
<td>Y</td>
</tr>
<tr>
<td>18</td>
<td>Physiology</td>
<td>F</td>
<td>22</td>
<td>Y</td>
</tr>
<tr>
<td>19</td>
<td>Biomedical Science</td>
<td>F</td>
<td>21</td>
<td>Y</td>
</tr>
<tr>
<td>20</td>
<td>Biomedical Science</td>
<td>M</td>
<td>21</td>
<td>Y</td>
</tr>
<tr>
<td>21</td>
<td>Biomedical Science</td>
<td>F</td>
<td>21</td>
<td>Y</td>
</tr>
<tr>
<td>22</td>
<td>Physiology</td>
<td>F</td>
<td>21</td>
<td>Y</td>
</tr>
<tr>
<td>23</td>
<td>Neuroscience</td>
<td>F</td>
<td>23</td>
<td>Y</td>
</tr>
</tbody>
</table>

Appendix 3: Nature and location of research placements in 2013-14 (n=23)

<table>
<thead>
<tr>
<th>PLACEMENT INSTITUTION</th>
<th>number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry (Research and Development)</td>
<td>2</td>
<td>8.6</td>
</tr>
<tr>
<td>Hospital / medical centre</td>
<td>3</td>
<td>13.0</td>
</tr>
<tr>
<td>Research institution</td>
<td>6</td>
<td>26.0</td>
</tr>
<tr>
<td>University</td>
<td>12</td>
<td>52.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GEOGRAPHICAL LOCATION</th>
<th>number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Home’ city (i.e. location of University X)</td>
<td>8</td>
<td>34.8</td>
</tr>
<tr>
<td>Other UK location</td>
<td>10</td>
<td>43.5</td>
</tr>
<tr>
<td>Overseas (Europe)</td>
<td>3</td>
<td>13.0</td>
</tr>
<tr>
<td>Overseas (outside Europe)</td>
<td>2</td>
<td>8.6</td>
</tr>
</tbody>
</table>
**Appendix 4: Pre-placement questionnaire**

**Questionnaire for PTY Students Prior to Commencement of Placement (2012-13)**

**Finding your placement:**

1. How many placement positions did you apply for?
   - a. Formal applications for advertised position
   - b. Informal/speculative approaches

2. How many interviews did you have?

3. What was your main reason for selecting your placement? (Select one)
   - Research topic
   - Experimental techniques
   - Supervisor
   - Nature of research establishment (e.g., pharmaceutical company, hospital)
   - Paid placement
   - Cardiff location
   - Other geographical location
   - No other choice
   - Other (please give details)

4. How do you expect to fund your placement year? (Tick all that apply)
   - Fully paid (salary) by placement provider
   - Research stipend from placement provider (please give approximate value of stipend)
   - External grant funding (please give details of grant-giving body and approximate value of award)
   - Student loan
   - Independent financial arrangement
   - Other support (e.g., accommodation) (please give details)

**Your expectations of the placement:**

5. How do you rate your CURRENT skill level at each of the following:

<table>
<thead>
<tr>
<th>Skill</th>
<th>WEAK</th>
<th>AVERAGE</th>
<th>EXCELLENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data handling/numeracy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graph plotting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature retrieval and reviewing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Networking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presentation skills</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statistical analysis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Writing/reporting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word processing</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Which of the following technical skills do you expect to gain from your placement (tick all that apply)?
   - Biochemical assays
   - Cell culture techniques
   - Electrophysiological recording techniques
   - Human subject studies
   - Immunohistochemical techniques
   - In vivo techniques
   - Microscopy techniques
   - Molecular biology techniques
   - Other (please give details)

7. Are you considering a career in research?

8. What are your current career aspirations, if any?

**Other comments:**

---

Sarah Hall | QUESTIONNAIRE PRIOR TO COMMENCEMENT OF PLACEMENT (2012-13)
Appendix 5: Post-placement questionnaire

QUESTIONNAIRE FOR PTY STUDENTS FOLLOWING RETURN FROM PLACEMENT (2014-15)

Student number:

I would be very grateful if you would complete this questionnaire relating to your experiences and perceptions of your PTY placement.

Completing the questionnaire should take no more than 5 minutes. There are a total of FOUR pages (including this cover, with EIGHT questions).

The results of the study will be used for educational research purposes only. They will NOT be used for assessment or influence your progress in any way. All participation in the study is voluntary.

The study is undertaken in accordance with the guidelines of the British Education Research Association (BERA) and with local ethical approval from the School of Biosciences.

You may return this form in electronic or hard-copy format:
- Electronic forms can be sent by e-mail: [email protected]
- Hard copies can be left in the folder on my office door (CL.07) or in the box in the UG office.

Please get in touch if you have any questions or comments.

With many thanks for your participation,
Sarah

Sarah Hall

1. Please indicate which of the following technical skills you have gained during your PTY, and your level of proficiency:

<table>
<thead>
<tr>
<th>Skill</th>
<th>N/A</th>
<th>Limited experience (under supervision)</th>
<th>Limited experience (working independently)</th>
<th>Extensive experience (under supervision)</th>
<th>Extensive experience (working independently)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biochemical assays</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cell culture techniques</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer modelling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrophysiological recording</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immunohistochemistry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In vivo experiments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microscopy and Imaging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molecular biology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physiological measurements from humans/patients</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transgenic animal models</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Please give your response to the following statements (ignore any aspects that do not apply):

<table>
<thead>
<tr>
<th>Skill</th>
<th>N/A</th>
<th>Disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Agree strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data handling / numeracy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graph plotting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature retrieval and reviewing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Networking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presentation and public speaking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statistical analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Writing / reporting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word processing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (e.g. speaking a foreign language)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Please comment on if / how your career aspirations have changed as a result of your PTY.
4. Please give your response to the following statements:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Degree strongly</th>
<th>Disagree</th>
<th>Neither/Agree nor Disagree</th>
<th>Agree</th>
<th>Agree strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>At the end of my PTY, I consider that I was...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>...better prepared for my final year project work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>...better prepared for other aspects of academic work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>...anxious about returning to student life</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Please give your response to the following statements:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Degree strongly</th>
<th>Disagree</th>
<th>Neither/Agree nor Disagree</th>
<th>Agree</th>
<th>Agree strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Since doing my PTY, I have...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have a better understanding of what it means to be a scientist</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel more like a “real” scientist</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have a better understanding of how academic subjects can be applied in the work environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am more confident about the process of applying for a job/further study</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have a clear idea about what I will do after graduation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am more likely to seek a career in research</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am more likely to undertake further study/training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Please give your response to the following statements:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Degree strongly</th>
<th>Disagree</th>
<th>Neither/Agree nor Disagree</th>
<th>Agree</th>
<th>Agree strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>My PTY was a positive experience overall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My PTY has given me a valuable scientific experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My PTY has given me useful employability skills</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My PTY was a worthwhile personal experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I wish I hadn’t done a PTY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Please comment on any specific positive experiences of your PTY year:

7b. Please comment on any specific negative experiences of your PTY year, including areas for improvement:

8. Please give details of any publications, including those in press or in preparation, that may arise from the work you completed during your PTY (e.g., research papers, poster presentations, talks, information sheets, internal reports, book chapters, booklets, etc.). Full reference details are not essential.

- Thank you for your help -
AUTHENTIC LEARNING: THE PTY STUDENT’S EXPERIENCE
Information sheet

You are invited to take part in a research study. Before you decide whether you wish to participate, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully.

- **What is the purpose of the study?**
  To investigate the authentic learning experiences of undergraduate Biomedical Sciences students who undertake a professional training year. The aims of the research are:
  - To assess students’ perceptions and actual experiences of the placement year.
  - To audit the specific and transferrable skills developed through authentic learning experiences.
  - To assess the impact of the placement year on students’ academic performance and career aspirations.

- **Who will be chosen for the study and do they have to take part?**
  Study participants will be undergraduate Biomedical Sciences students of [_____] on PTY placement during 2013-14. All participation will be voluntary.

- **What will happen if I take part and what do I have to do?**
  You will be asked to complete a brief questionnaire on two occasions (before and after your placement). This questionnaire will ask for your opinions and perceptions of your placement; data on the nature of the placements and the skills developed will also be collected. In addition, cohort analysis of end-of-module assessment data will be undertaken.

- **What are the possible disadvantages and risks of taking part?**
  There are no disadvantages or risks associated with participation.

- **What are the possible benefits of taking part?**
  The results of this study will be used to inform and improve students’ experiences on 4-year (placement year) Biomedical Sciences degree schemes.

- **What if there is a problem?**
  You are free to withdraw from the study at any time without needing to give a reason, and without prejudice.

- **Will my taking part in the study be kept confidential?**
  Yes. Subject identity will be anonymised and all subject information will be coded in all aspects of the study. No individual will be identified in the final report.

- **What will happen to the results of the research study?**
  Data from this study will be stored securely on password-protected University databases for the duration of the study (June 2013-September 2015). The findings will be written up as a thesis for the MA (Education) degree and may also be submitted for publication in a peer-reviewed journal.

- **Who is organising and funding the research?**
  This study is supervised by Dr Sarah Hall, and is funded internally by the School of Biosciences.

- **Who has reviewed the study?**
  This study has been reviewed by the School of Biosciences Ethics Committee.

---

Who can I contact for further information about the research?
Dr Sarah Hall

What happens now?
Dr Sarah Hall will contact you.

Principal Researcher: Contact details must be provided here:
Dr Sarah Hall

In case of complaint, please contact the School of Biosciences Ethics Committee Secretary:
Email: [_______]
Phone: [_______]
Address: [_______]