Long-term behavioural change and impact of Intersect Australia digital skills training on researchers' workflows and research outputs

Dr Anastasios Papaioannou[1], Dr Jianzhou Zhao[1], Aidan Wilson[1,2], Dr Sam Ryan[1,3], Marium Afzal Khan[1,4], Dr Ghulam Murtaza[1], Dr Jonathan Arthur[1]

[1] *Intersect Australia, Sydney, Australia*
[2] *Australian Catholic University, Sydney, Australia*
[3] *La Trobe University, Melbourne, Australia*
[4] *University of Adelaide, Adelaide, Australia*

TABLE OF CONTENTS

1. Introduction

Intersect's mission is to help researchers to be more efficient and effective in their research; reducing the time to move from an idea to a tested solution. As a leading provider of digital skills training for researchers in the Australasian region, Intersect provides an extensive range of technology focused training to researchers and higher degree research (HDR) students across Australia. This training ranges from awareness to advanced levels; is delivered interactively either face-to-face or online; and covers categories such as Research Computing, Programming, Data Science, Data Analytics, Machine Learning (ML) & Artificial Intelligence (AI), Statistics, Data Visualisation, Data Collection, and Data Management. Intersect continually revises, updates, and expands its course catalogue, ensuring researchers always have access to the most relevant and useful research training.

Our hands-on, instructor-led, live, interactive training is delivered by over 25 highly experienced instructors and is targeted at enhancing the capabilities of researchers in digital tools and technologies. Our research and training expertise extends across various disciplines including, but not limited to: ICT, Data Science, Linguistics, Engineering, Statistics, Bioinformatics, Health & Medical Sciences, Materials Science, Sports Science, Spatial Analytics, Computational Chemistry, Numerical Modelling, Behavioural Science, and Social and Political Sciences.

Since the inception of Intersect's training program in 2012, over 30,000 trainees (comprising over 13,000 unique participants) have completed Intersect Australia training. Over 2,000 courses have been delivered, across 40+ universities and research-intensive organisations in Australia. In 2021, 6,728 researchers were trained and 349 courses (270.5 training days) were delivered. This equates, on average, to at least one training course for every working day of the year. Intersect operates a comprehensive, data-driven quality control process to ensure robust, quality delivery of training, including a course evaluation survey at the end of each course to generate a Net Promoter Score (NPS)[1]. Intersect's NPS in 2021 was +75 based on more than 2,500 responses; this is considered outstanding. The average scores of the five primary metrics for measuring the quality of the training delivery exceed 9.4 out of 10, which indicates that feedback from participants is excellent.

While short-term assessment of trainee satisfaction with our training program is successfully captured and reported via the aforementioned method, determining long-term behavioural change on HDR students, researchers, and staff is more challenging yet equally important in evaluating the impact of digital skills training. To this end, Intersect has developed a Training Impact Survey to assess the long-term impact of our digital skills training on researchers. In addition, the survey aims to gain insights into other key areas of interest, including whether there is a link between digital tools/technologies and research outputs and investigating the support services researchers use for additional research assistance after training. This survey is now sent biannually to our member university researchers and staff who attended our training a year prior. In the first distribution (June 2021), the survey was sent to those who attended a course between January 2019 and June 2020. We received 740 responses out of approximately 4,800 invitations, a response rate of more than 15%. Subsequently, we sent the survey to those who attended a course from July 2020 to April 2021 and we received 610 responses out of approximately 4,600 invitations. We aggregated the responses from both iterations of the survey and the findings and detailed analytics are presented in this report.

[1] The Net-Promoter Score is calculated by subtracting the percentage of detractors (answering between 0 and 6) from the percentage of promoters (those answering either 9 or 10) and can range from -100 (everyone is a detractor) to +100 (everyone is a promoter). An NPS that is 0-30 is seen to be good, 30-70 is great, and an NPS of 70+ is excellent. https://en.wikipedia.org/wiki/Net_promoter_score

2. Intersect Course Attendance Demographics

The first section of this report provides detailed analytics about Intersect's training program. All the figures and analytics in this section utilise course and attendance data between 2016 and 2021. It only includes attendees with research-related roles. As such, attendance data in this report may vary from total attendance data reported in other channels.

2.1 Attendance by Tool/Technology

Figure 2.1.1 (left) shows the percentage of the attendees by tool or technology considering attendees from 2016 to 2021. It shows the percentages for the eight most commonly chosen technologies out of the 22 tools or technologies covered by the Intersect training catalogue. R was the most popular tool (30.2% of all students), followed by Python (24.43%). Microsoft Excel is the third most popular tool with approximately 17% of all students. These three tools, in total, attracted more than 70% of the course attendees. Approximately 13% of the participants attended courses covering the data collection tools, *i.e.*, 7.9% for REDCap and 5.4% for Qualtrics. It is also worth noting that slightly over 5.5% of the attendees studied NVivo for qualitative data analysis. This makes it the fifth most popular tool in Intersect's course catalogue, despite the fact that the NVivo courses were first introduced in mid 2020.

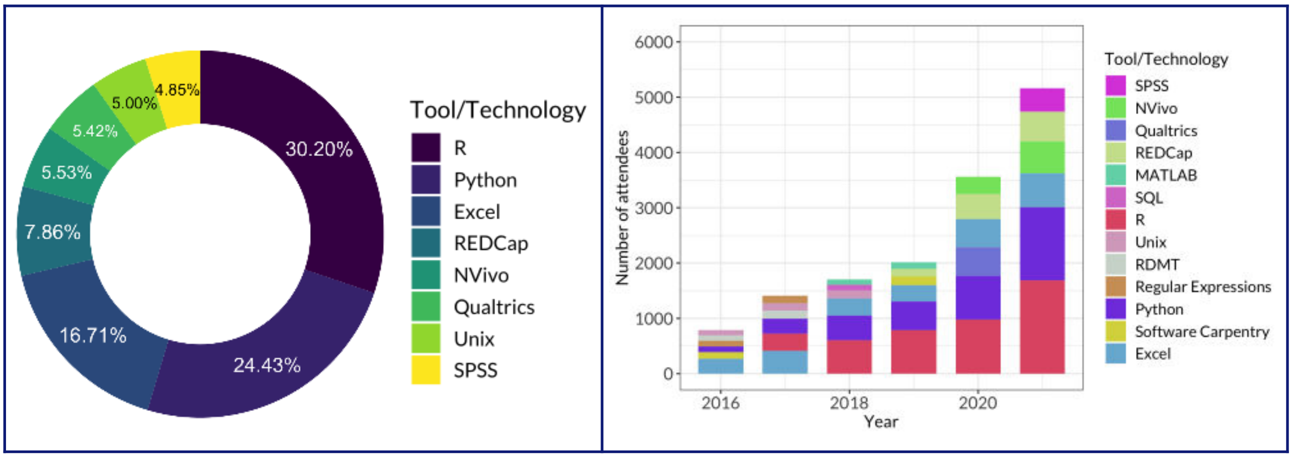


Figure 2.1.1: (Left) Distribution of number of attendees by tool/technology. Data from 2016 to 2021 were considered in this graph. Only the top 8 most commonly chosen tools/technologies taught by Intersect Australia are displayed; (Right) Distribution of number of attendees by tool/technology for each year from 2016 to 2021. Only the 6 most popular tools/technologies are displayed for each year.

Figure 2.1.1 (right) shows the number of attendees for the 6 most popular tools each year from 2016 to 2021. Microsoft Excel was the most popular tool taught until 2017, however, in 2018, programming tools jumped to the top of the list. Since then, there has been a steady uptake of both R and Python courses by training attendees until 2020, followed by a significant increase in 2021 when around 3,000 participants attended R and Python courses. The popularity of the two data collection tools, namely REDCap and Qualtrics, increased in 2020, with approximately 500 attendees learning each tool in that year. We hypothesise that the noticeable increase in the uptake of the data collection tools might be related to the pandemic and the need for researchers to implement more robust surveys and data collection workflows, which do not require in-person distribution. However, testing the veracity of this hypothesis is beyond the scope of this survey. Intersect introduced training for NVivo in 2020 and it quickly overtook REDCap in 2021, to be the fourth most popular course of the year, behind R, Python, and Microsoft Excel.

2.2 Attendance by Role/Position

The majority of the training attendees were Higher Degree Research (HDR) PhD students (about 61%). Exactly 15% were Postdoctoral researchers or Fellows and 13% were Academics. HDR Master students and Professional staff (who contribute to research) shared the remaining 11%.

As seen from Figure 2.2.1 (right), the majority of attendees each year were HDR PhD students. Between 2016 and 2018, the second largest cohort was postdoctoral researchers and fellows. However, since 2019, Academics have become the second largest cohort, with their relative proportion of total attendees continuing to increase. In 2021, a substantial increase in the uptake of Intersect training courses was observed among the professional staff (research-related) cohort. This may be due to the pandemic, with academic researchers unable to undertake field work or attend the laboratory turning their attention to data analytics. Alternatively, it may reflect the increasingly data-centric nature of research, resulting in digital tools and technologies becoming an integral part of the research lifecycle. In either case, it certainly represents a need and interest in personal professional development with these tools and technologies.

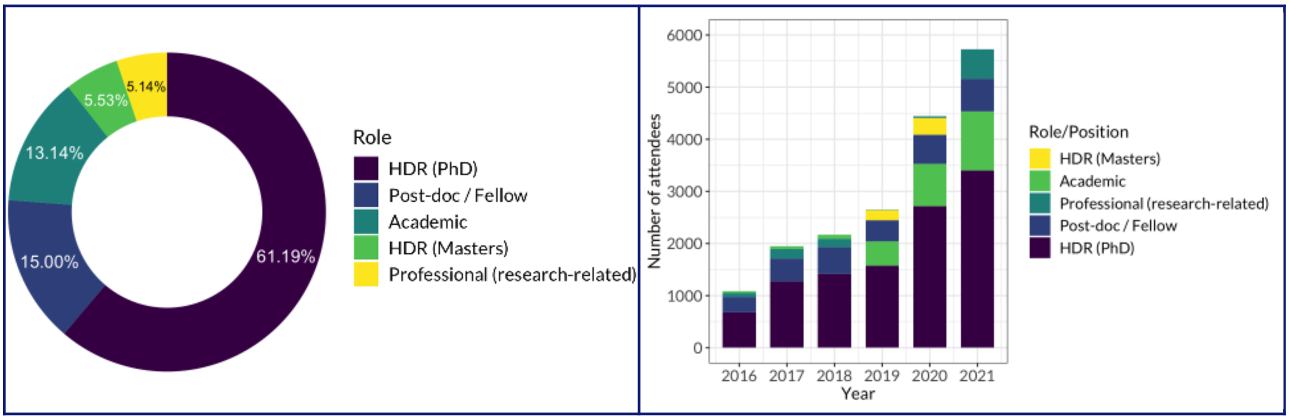
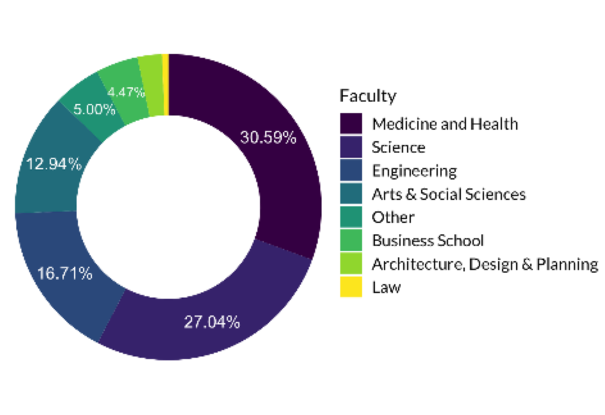


Figure 2.2.1: (Left) Distribution of training attendees by Role/Position. Data from 2016 to 2021 were considered in this graph. Only research-related positions are displayed; (Right) Distribution of training attendees by Role/Position for each year from 2016 to 2021.

2.3 Attendance by Faculty

It is important to note that Intersect Australia only collects Field of Research (FoR) codes from participants during the registration process. The Faculty names were selected by Intersect Australia (with reference to the most commonly used Faculty names among institutions) and a mapping process between the Field of Research (FoR) codes and Faculty names was carried out to derive the data presented here.

From the distribution of attendees by Faculty, shown in Figure 2.3.1 (left), nearly a third of attendees came from the Faculty of Medicine and Heath, whereas about 27% and 17% were from the Faculty of Science and the Faculty of Engineering, respectively. The Faculty of Arts & Social Sciences accounted for nearly 13% of the attendees, followed by the Business School, the Faculty of Architecture, Design and Planning, and the Faculty of Law. Collectively, this indicates that approximately 25% of attendees are from the Humanities, Arts, and Social Sciences. This demonstrates that digital research tools and technologies are not limited to the hard sciences, and that Intersect training is already reaching large cohorts of researchers from the HASS disciplines.



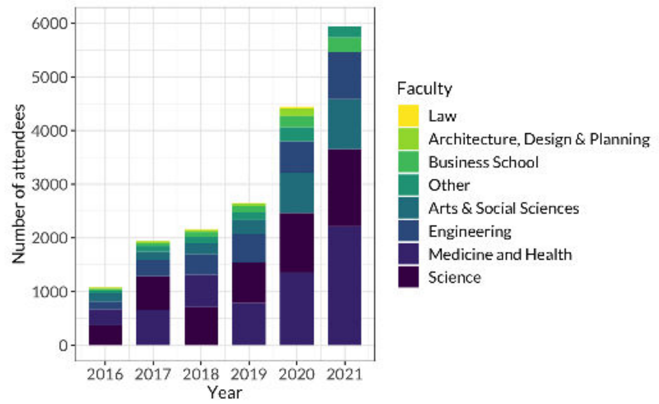


Figure 2.3.1: (Left) Distribution of attendees by Faculty. Data from 2016 to 2021 were considered in this graph. Only research-related positions are displayed; (Right) Distribution of Faculty breakdown of attendees per year from 2016 to 2021.

Figure 2.3.1 (right) presents the faculty breakdown of attendees per year. It is interesting to see that the number of attendees from the Faculty of Medicine and Health was similar to that of the Faculty of Science between 2016 and 2018. However, since 2019, the Faculty of Medicine and Health has become the largest faculty cohort utilising the Intersect training program. More importantly, the Faculty of Arts & Social Sciences has overtaken the Faculty of Engineering in the last two years, becoming the third largest faculty cohort in 2020 and 2021. This, together with the increase of the attendees from the Business School, the Faculty of Architecture, Design, and Planning, and the Faculty of Law, indicates good utilisation of Intersect's digital research training program by faculties that are conventionally considered to be less technology-oriented.

2.4 Returning to attend more Intersect courses

Attending Intersect courses more than once might be perceived in various ways:

- Digital tools and technologies are an integral part of research workflows and therefore researchers are willing to familiarise themselves with the most popular tools/technologies that are widely used in cutting-edge research
- Attendees are seeking professional development
- Intersect training courses are of high value and relevance to researchers that cannot be found in other sources/platforms

Hence, the number of times an attendee returned to attend more Intersect training courses was analysed by Role and Faculty. As seen from the boxplots shown in Figure 2.4.1, the frequencies between 2016 and 2018 were almost consistent, with a slight shift to higher numbers of courses observed for both HDR PhD students and Professional (research-related) staff. From 2019 and onwards, the frequencies of returning to a course increased significantly for all roles/positions. In particular, the HDR PhD students and Academics were more interested in attending several Intersect training courses with the median values for both roles being higher than 6 in 2021.

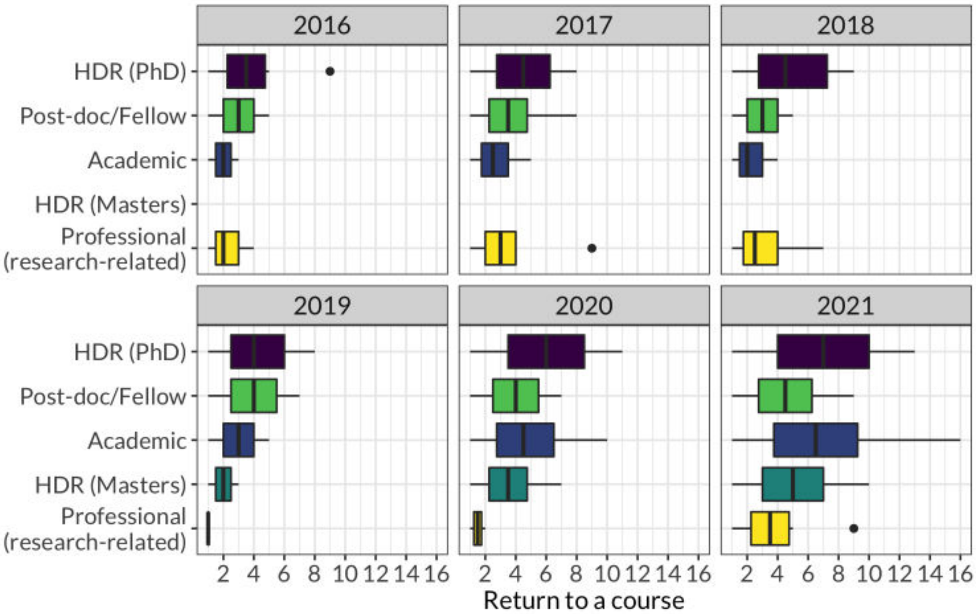


Figure 2.4.1: Distribution by year (2016-2021) of the number of times trainees returned to attend more Intersect training courses split by Role/Position.

Figure 2.4.2 below shows the distribution of returning participants to a course for each faculty. In terms of the top three faculties with the highest number of attendees (Science, Medicine and Health, Engineering), all have had a steady increase of the return frequencies, with the median number of courses attended by a participant rising from around 3 in 2016 to around 6 in 2021. In terms of the rest of the faculties, the number of returns to a course remained largely unchanged until 2019. However, with the introduction of online training delivery, the new NVivo courses, and targeted communication, the Faculty of Arts and Social Sciences, the Business School, and the Faculty of Architecture, Design & Planning had a significant increase in return frequencies from 2020 onwards. It is worth noting that the median number of returns to Intersect courses by attendees from Faculty of Arts and Social Sciences was nearly six, the highest among all faculties, in 2020. Even though the Faculty of Law did not have a similar distribution in the number of returns to a course as the other faculties, it is clear that more attendees from Law had returned to Intersect courses multiple times in recent years.

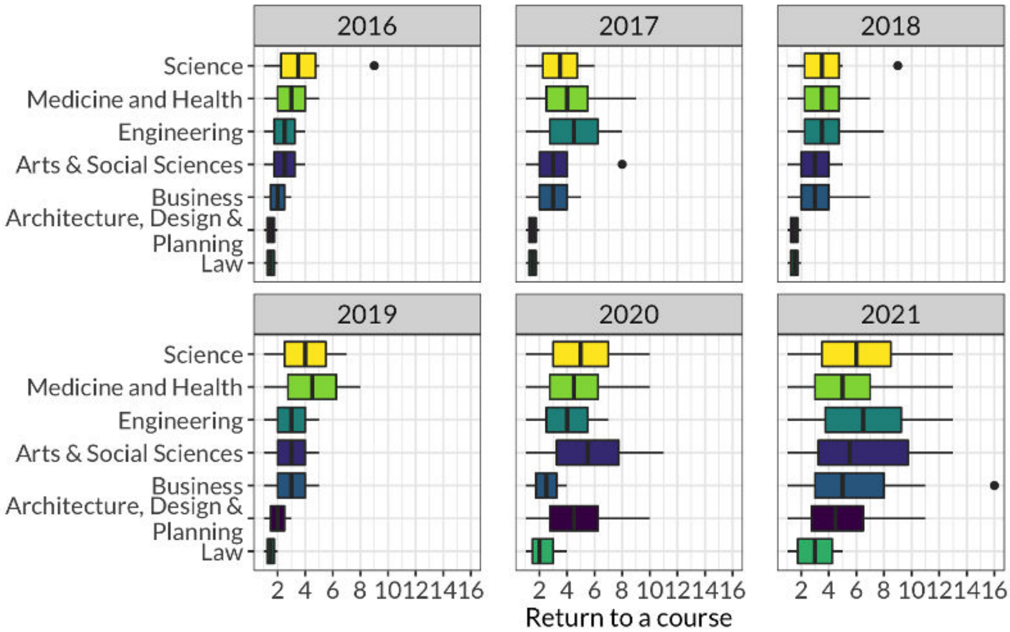


Figure 2.4.2: Distribution by year (2016-2021) of the number of times trainees returned to attend more Intersect training courses split by Faculty.

3. Long-term Training Impact

Data Science skills are, increasingly, an integral part of research and required to build a deeper understanding of research data. However, many researchers face a growing knowledge gap in these skills. The 2021 National Research Infrastructure Roadmap[2] mentions that:

"Rapid advances in computing techniques and analysis, and management of large and complex datasets, have resulted in researchers no longer having sufficient expertise in data management, computational and analysis techniques."

In 2016, a survey of 704 National Science Foundation (NSF) Biological Sciences Directorate principal investigators (BIO PIs) was conducted and nearly 90% indicated they are currently or will soon be analysing large data sets. However, BIO PIs said **the most pressing unmet needs are training in data integration, data management, and scaling analyses for HPC—acknowledging that data science skills will be required to build a deeper understanding of life[3].** This portends a growing data knowledge gap in biology and challenges institutions and funding agencies to redouble their support for computational training in biology [3]. Environmental and other scientists face the same issues and unmet need for training and mentorship in computational skills[4,5,6].

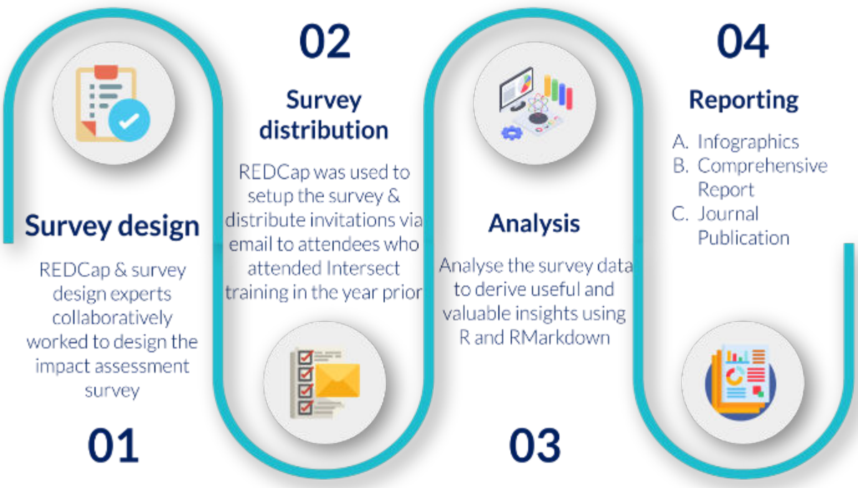
[2] https://www.education.gov.au/national-research-infrastructure/2021-national-research-infrastructure-roadmap
[3] Barone L, Williams J, Micklos D (2017) Unmet needs for analyzing biological big data: A survey of 704 NSF principal investigators. PLoS Comput Biol 13(10): e1005755. https://doi.org/10.1371/journal.pcbi.1005755
[4] Lowndes, J., Best, B., Scarborough, C. et al. Our path to better science in less time using open data science tools. Nat Ecol Evol 1, 0160 (2017). https://doi.org/10.1038/s41559-017-0160
[5] Baker, M. Scientific computing: Code alert. Nature 541, 563–565 (2017). https://doi.org/10.1038/nj7638-563a
[6] Stephanie E. Hampton, Matthew B. Jones, Leah A. Wasser, Mark P. Schildhauer, Sarah R. Supp, Julien Brun, Rebecca R. Hernandez, Carl Boettiger, Scott L. Collins, Louis J. Gross, Denny S. Fernández, Amber Budden, Ethan P. White, Tracy K. Teal, Stephanie G. Labou, Juliann E. Aukema, Skills and Knowledge for Data-Intensive Environmental Research, BioScience, Volume 67, Issue 6, June 2017, Pages 546–557, https://doi.org/10.1093/biosci/bix025

Hence, there is a pressing unmet need and demand for building the computational skills and capability of the research workforce in the use of cutting edge digital tools and technologies. Throughout the years, the mission of the Intersect training program has been to bridge this knowledge gap and meet the demand for upskilling the Australian research workforce on cutting edge digital tools/technologies. Intersect has, for many years, successfully and extensively captured and reported on short-term impact in the form of participant feedback, satisfaction, and training quality metrics[7]. However, determining long-term behavioural change and impact on Higher Degree Research (HDR) students, Post-doc/Fellows, Academics, and staff is more challenging. To this end, Intersect has developed a survey to assess the long-term impact of our digital skills training on researchers. In addition, we also sought to gain insights into two other key areas of interest: 1) the relationship between training and support structures at universities; and 2) the link between training and research outputs and grants.

3.1 Methods

This project involved eight team members from Intersect Australia. We started with internal discussions about the best ways to capture the long-term impact of our training program. We also conducted a literature review for other initiatives and explored other metrics used to capture training impact.

We routinely collect attendee information from Eventbrite after each course, and we curated a dataset that contained only email, university, faculty, FoR code, course attended, and course date, and imported that into a REDCap project. We broke the survey up into three major sections. The first section captures the long term impact of our training, whether the training has resulted in a change of behaviour, or improvement to the research workflow. The second section investigates the link between training attendance, and utilisation of other support services within the university, or elsewhere. The third section looks at the productivity of researchers who have attended our training *i.e.*, whether there is any link between our training and research outputs or research grant success. The Intersect team of REDCap and survey design experts collaboratively worked to design the impact assessment survey in REDCap and distribute invitations via email to thousands of researchers who attended Intersect training in the year prior.



[7] To evaluate the quality of the training delivery, Intersect instructors ask the attendees to fill in a course evaluation survey at the end of each course. In our course evaluation survey, a scale of 0 (worst) to 10 (best) is used. In addition, a Net-Promoter Score, in which attendees are asked how likely they are to recommend Intersect Training courses to others, is also measured.

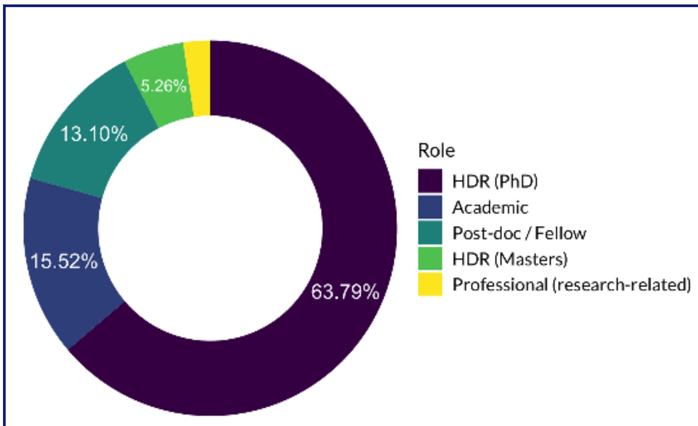
Figure 3.1.1: Planning flowchart of Intersect's long-term training impact project.

The survey was distributed in two rounds to collect responses from attendees. In the first round, the survey was distributed to 4,859 attendees who attended one or more Intersect courses between February 2019 and June 2020. In the second round 4,605 attendees who attended one or more Intersect courses between June 2020 and April 2021 received the survey. Intersect received 743 (about 15.3% response rate) and 609 (about 13.2% response rate) responses in the first and second round, respectively, a total of 1,352 responses across 13 universities in Australia. In this report, we only analysed the responses (a total of 1,160) from the research-relevant roles, namely, HDR students (PhD and Masters), Post-doc/Fellow, Academic, and Professional (research-related).

After the two distributions, the data was exported without any identifiers for data analysis. We are in the process of integrating this long-term training impact survey with Intersect training systems as an ongoing operational process.

3.2 Training impact survey demographics

HDR (PhD) students are the largest cohort by role to respond to the training impact survey with approximately 64% of responses, followed by Academics (approximately 16%) and Post-doc/Fellows (approximately 13%). Although the percentages of training impact survey responses (Figure 3.2.1 left) are aligned with the percentages of training attendance (Figure 2.2.1 left) for most roles, we observe a higher percentage of Academics responding to the training impact survey and a lower percentage of Post-doc/Fellow. As for the tool/technology, the most frequent research tool/technology associated with responses to the training impact survey was R. This tool had substantially more responses, at 28%, than the next most frequently reported tool. Researchers who attended Python courses were the second largest group to respond to the training impact survey (approx. 19%) followed by Excel (approx. 14%), Qualtrics (approx. 10%), REDCap (approx. 9%), NVivo (approx. 6%), and SPSS (approx. 5%). It is important to note that only the top 10 tools/technologies are displayed in this figure.



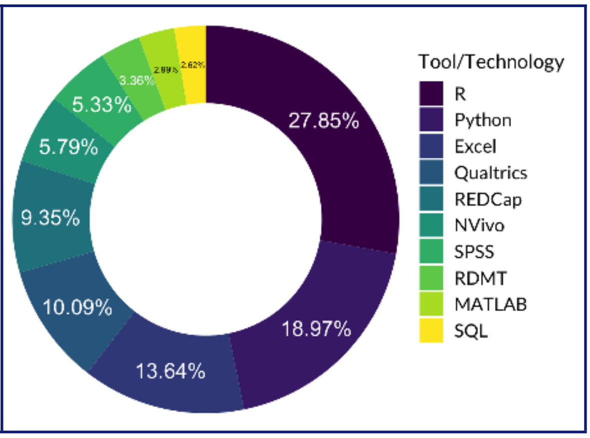


Figure 3.2.1: (Left) Distribution of survey responses by Role/Position of attendees; (Right) Distribution of survey responses of the 10 most popular course tool/technology participants attended.

The Faculty of Medicine and Health is the largest faculty group to respond to the training impact survey (approx. 37%). This group comprises all Medicine and Health faculties, such as Public Health and Biomedical and Clinical Sciences. The second largest response group is the Faculty of Science (25%), followed by the Faculty of Arts and Social Science and Faculty of Engineering that had a similar number of responses with approximately 13.4% and 12.2%, respectively. In the FoR distribution figure, only the top 10 FoR codes are shown. Health Sciences was the largest FoR group to respond to the training impact survey (about 37%), while Engineering was the second (about 11%). A similar number of responses was observed from Psychology and Biological Sciences with a percentage of approximately 9%. Education constitutes about 7.5% of responses while Agricultural, Veterinary and Food Sciences; Commerce, Management Tourism and Services; as well as Environmental Sciences had a percentage of responses between 6.2% and 5.3%.

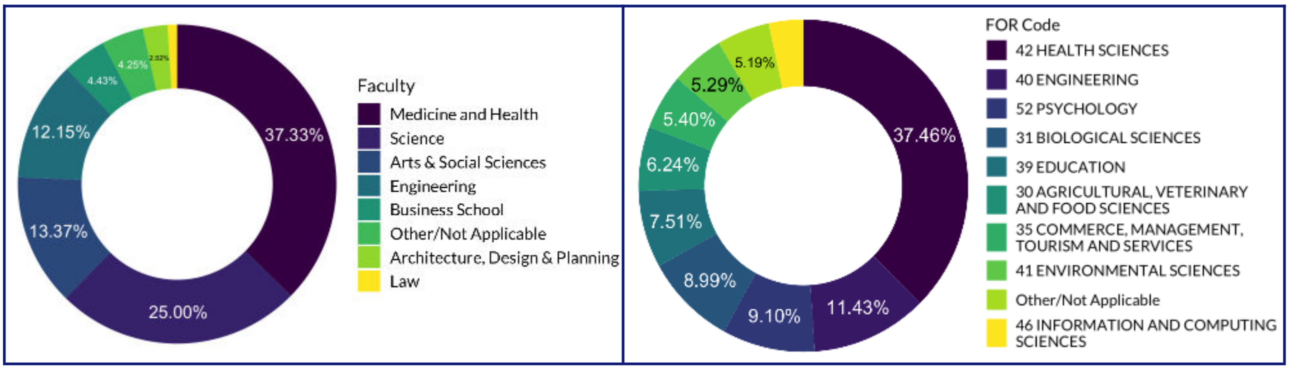


Figure 3.2.2: (Left) Distribution of survey responses by Faculty of attendees; (Right) Distribution of survey responses by top 10 FoR of attendees.

3.3 Kirkpatrick's metrics

In designing the first section, we sought a standard model that is used in evaluating training in industrial contexts, and came across the Kirkpatrick model of training evaluation. In 1959, Donald Kirkpatrick developed a model to evaluate how participants reacted to a training program within higher education[8]. The model has been revised and developed further, and become overwhelmingly popular for training evaluations (2016)[9]. It assesses the effectiveness of a training program with a four-level approach, each building on the previous in terms of value, and from immediate to long term:

1. **Reaction**: The first level is reaction, or, did the learners enjoy the training. The reaction level measures the extent to which participants are positively or negatively disposed toward the training program. For this level, Intersect asks the question "*Do you feel that attending the course was worthwhile to you?*"
2. **Learning:** The second level is learning, or, did learning transfer occur. The learning level determines how much the participants learned during the training. For this, Intersect asks the participants "*Do you feel more or less confident using technology since taking the course?*"
3. **Behaviour**: The third level is behaviour, or, did the training change the learner's behaviour. The behaviour level evaluates the changes in the behaviours of the participants as a result of the training program. For this, Intersect asks "*How frequently were you able to apply technology in your research/work since the course?*"
4. **Results:** The last level is results, or, did the training improve the learner's performance, where performance in this industry might mean research productivity or research outputs. The results level examines the outcomes which can be attributed to the training program. For this, Intersect asks "*To what extent has technology been helpful to your research/work?*"

Figure 3.3.1 presents the responses from survey participants according to Kirkpatrick's four levels of training

[8] Kirkpatrick, D. L. (1959). Techniques for evaluation training programs. Journal of the American Society of Training Directors, 13, 21-26.
[9] Kirkpatrick, J. D., & Kirkpatrick, W. K. (2016). Kirkpatrick's four levels of training evaluation. Association for Talent Development.

education, namely, Reaction, Learning, Behaviour, and Results. Approximately 79% of respondents indicated that the training course they attended was either "extremely worthwhile" or "very worthwhile" (Reaction). This demonstrates that the majority of attendees considered attending an Intersect course to be a valuable use of their time. Over 87% of survey respondents indicated that they feel "much more" or "more" confident using the research tool than they did prior to attending the training course (Learning). This indicates a good understanding of the content in a way that is applicable to those researchers' use cases, making them feel comfortable to apply the concepts and skills gained in the training course to their own research.

Approximately 80% of respondents have continued to use the digital tools they learnt about during the training course at least "sometimes". Worth noticing that approximately 51% of attendees use the tool "frequently" or "often" following the course (Behaviour). This suggests that attendees feel comfortable using the tool and are subsequently applying what they have learned during the training course in their research. Nearly 64% of survey respondents indicated that the training course was "extremely" or "very" helpful in producing results of their analysis in subsequent research.

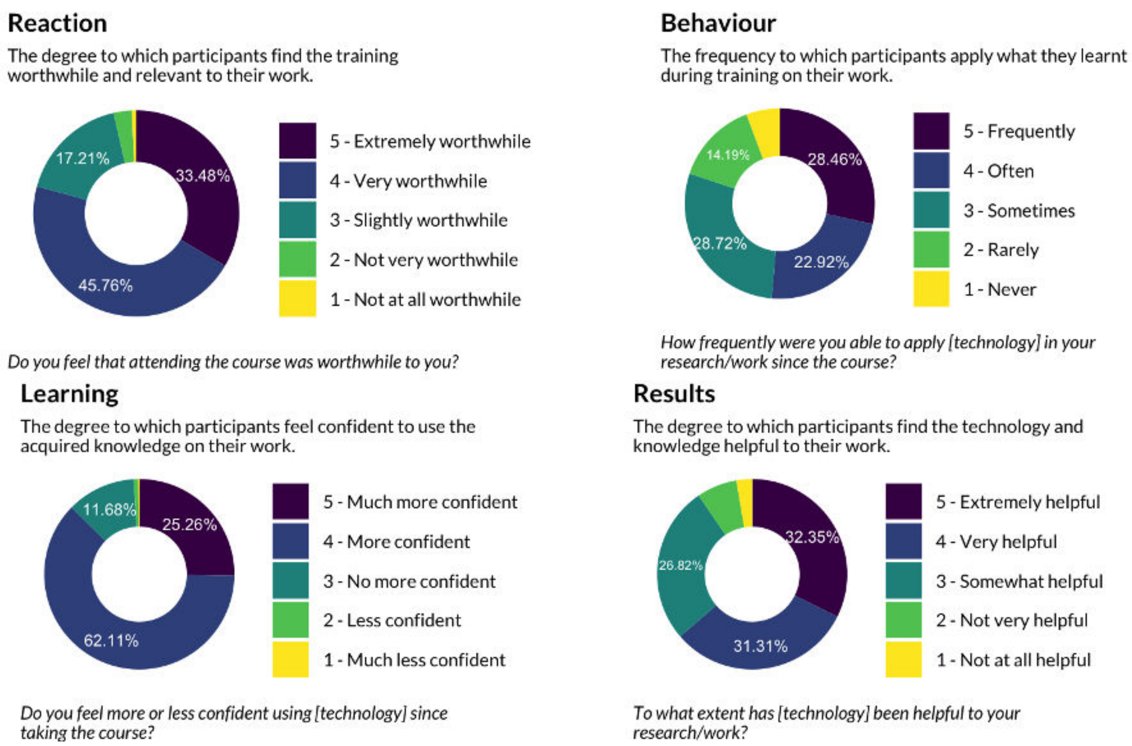


Figure 3.3.1: Distribution of survey responses based on Kirkpatrick's four levels of training evaluation, namely Reaction, Learning, Behaviour, and Results.

Further analysis for Kirkpatrick's four levels of training evaluation was conducted based on Role/Position, Faculty and Tool/Technology to gain more insights.

Reaction

It is encouraging to see more than 70% of respondents — rising to more than 82% in the case of R, Excel, Qualtrics, REDCap, and SPSS — found the training on the ten most popular digital research tools, either "very" or "extremely" worthwhile, except for NVivo. Interestingly, these two options for NVivo constitute 61.3% which is still considered high but not as high compared with the other digital tools/technologies. When the responses are analysed by Role, a consistent trend similar to the overall summary shown in Figure 3.3.1 (Reaction) was found across all roles/positions. Analysing the data by faculty also shows a consistent trend except for the Faculty of Architecture, Design and Planning where the two options, “very” or “extremely” worthwhile, constitute 62.1%.

Learning

Similarly, analysis on **Learning** based on Role/Position, Faculty, and Tool/Technology have shown consistent trends with the overall results (see Figure 3.3.1 (Learning)). The only faculty showing a slightly decreased percentage when the options “5 - Much more confident” and “4 - More confident” are calculated together is the Faculty of Law with 72.7%, although this is still considered high. In terms of Tools/Technologies, only MATLAB was found to have a small decrease (77.4% for options 5 and 4 combined) compared to the overall trend.

Behaviour

The analysis on **Behaviour** indicated different patterns for how frequently attendees have applied what they learnt in the training courses to their work. When options 5, 4, and 3, namely Frequently, Often, and Sometimes, respectively, are combined, Professional staff (research-related) is the only role that shows a decreased percentage (66.7%) compared to the other roles (between 77% and 82%). Analysis on Behaviour by Faculty shows a similar trend amongst all faculties. Unsurprisingly, the majority of respondents, after the training, have either “frequently”, “often”, or “sometimes” used the tools in their research work. Only 17.9% of respondents who attended the Introductory SQL course answered that they applied SQL to their research “often” or “frequently”, while when “sometimes” is also considered the percentage is 53.6%, which was the lowest among all tools/technologies. This might suggest that further learning is needed for researchers to be able to apply SQL into their research. It is worth mentioning that Excel and Qualtrics are the tools that scored the highest when “frequently”, “often”, or “sometimes” are taken into account with 93.8% and 90.7%, respectively, indicating that attendees of Excel and Qualtrics courses are able to translate all the concepts they learnt into their research. All the rest of the tools/technologies scored a percentage between 72% and 83%.

Results

The distribution of responses by Role/Position is similar to the overall trend and no significant differences were observed. In regards to the various faculties, when comparing with the overall distribution shown in Figure 3.3.1 (Results), the Faculty of Law recorded a percentage of 36.4% when the options “extremely” and “very” helpful were combined, which is significantly lower than the average percentage (64%), followed by the Faculty of Arts and Social Sciences (55.9%). This might be due to the fact that participants from these two faculties are conventionally less technology-oriented but, having said that, almost 89.5% and 81.8% of the respondents from the Faculty of Law and the Faculty of Arts and Social Sciences reported the tools are at least “somewhat” helpful, which is similar to the other faculties. Most respondents (over 85%) acknowledged that all tools/technologies are at least “somewhat” helpful to their research work except for SQL, where only 60.7% of respondents answered at least “somewhat” helpful. This further suggests that researchers face difficulties at adapting SQL to their research work. Furthermore, it is worth noting that 71-80% of the respondents found that Excel, Qualtrics, REDCap, SPSS, and HPC are “very” or “extremely” helpful to their work.

3.4 Would access to the materials prior to a course inhibit attendance?

Nearly 83% of survey respondents stated that they would definitely or probably attend the training course if they were provided with the course material prior to training. This highlights the value of the live, interactive, and hands-on nature of training; the instructor's explanations of concepts; and the formative assessments throughout the course that cannot be achieved by working independently with the course notes.

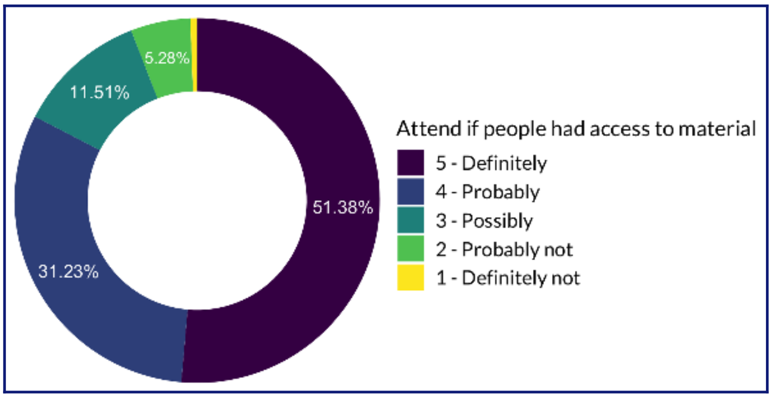


Figure 3.4.1: Distribution of responses about whether participants of an Intersect training course would still attend the course if they had access to the material prior to the delivery.

In addition, analysis of the responses by Roles/Positions, Faculties, and Tools/Technologies was carried out and revealed a consistent distribution similar to the one presented in Figure 3.4.1. This further demonstrates that participants from all Roles and Faculties that attended Intersect courses in various tools/technologies value attending the course itself and the extra learning and interactivity provided by the instructor(s) which cannot be obtained from the course materials alone. It is worth highlighting that nearly 75% of the respondents from the Business School would **definitely** attend the training course even if they had access to course material prior to the delivery.

Similarly, the distribution of responses for all tools and technologies is consistent with that of Figure 3.4.1, except for RDMT (Research Data Management Techniques). Nearly 50% of the respondents would either probably or probably not attend the RDMT training if they had access to material. This course was intentionally developed in a lecture style. As a result, the delivery is less interactive compared with all other Intersect training courses. We assume that attendees would most likely obtain similar learning outcomes if they conducted self-learning with the course material and this appears to be reflected in the survey responses.

3.5 Post-training support

Another aspect of the impact of training of interest to Intersect is whether training participants have received further support following training and, if so, the form of that support. Our survey included the following forms of support: Peer support, Intersect eResearch Analyst, Other University services, Other Intersect training, and Self-paced training.

About 67% of respondents answered that they have received further support after completing an Intersect training course. Peer support was the most popular method of post-training support with about 30% of participants using this channel. Intersect provided approximately 34% of post-training support via Other Intersect training or Intersect eResearch Analyst support/consultation. Of those who received further support, about 42% reported that it was in the form of additional training, either Self-paced or Other Intersect training, after the original Intersect training course. Interestingly, only 15% of participants responded that they utilised Other University Services for further support. The relatively high percentage of peer support and low percentage in Other University services and Intersect eResearch Analyst support indicates that the researchers are relying heavily on receiving support from their peers, rather than expert advice, when they face issues and challenges when using the digital tools/technologies for their research. We assume this might be due to the limited resources available to the researchers for further support either through the university or by having only one Intersect eResearch Analyst to support the whole research community on digital tools/technologies related questions and issues.

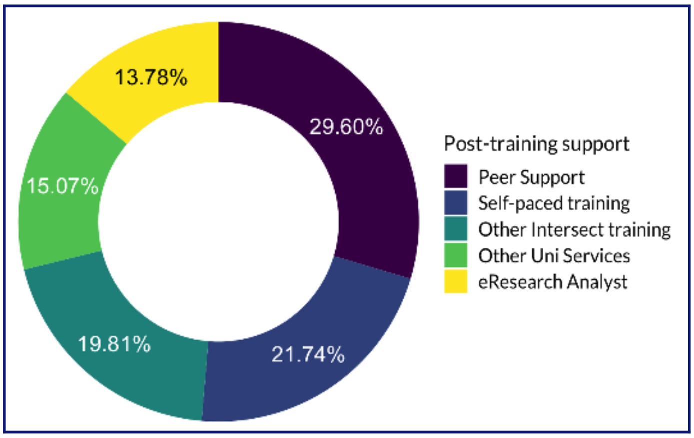


Figure 3.5.1: Distribution of responses in the following question about receiving further support after completing an Intersect training course: "Have you received further support after attending the [course name] course? (Select all that apply)".

Peer Support is consistently the most popular method for further support amongst all Roles/Positions with a percentage between 28% and 37%. Other Intersect training is the second most popular method of further support for Post-doc/Fellow (24%), while Academics show an equal distribution of responses across all categories of post-training support other than Peer Support. eResearch Analyst support was reported to be higher among Professional (research-related) (21%), Academic (19%), and Post-doc/Fellow (17%) roles compared to HDR students (PhD and Masters). On the other hand, the Other University Services category is higher among HDR students and Academic (about 16% for all roles) compared to Professional and Post-doc/Fellow.

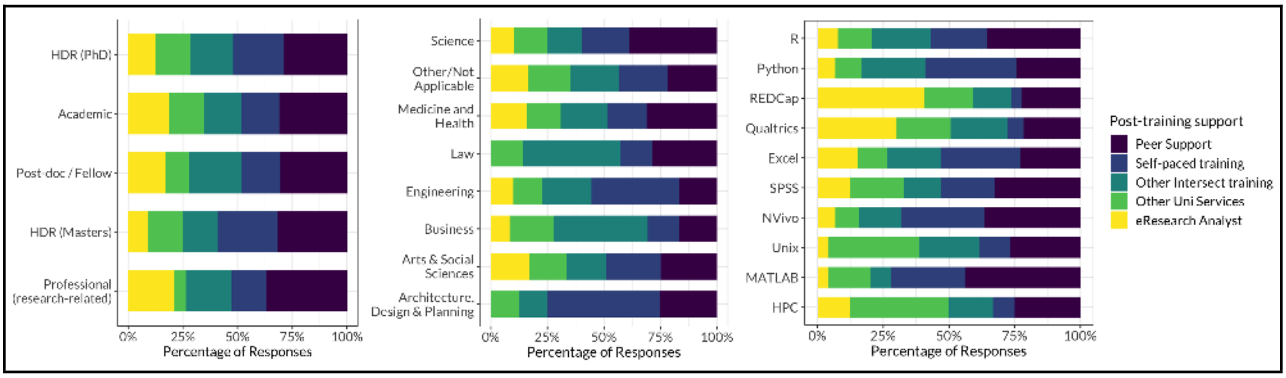


Figure 3.5.2: Distribution of responses about receiving further support after attending an Intersect training course further split by (Left) Role/Position; (Middle) Faculty; (Right) the top 10 Tools/Technologies.

The Faculty of Medicine and Health and the Faculty of Arts & Social Sciences show quite similar distributions, however Peer Support was the most popular category following by Other Intersect training for the Faculty of Medicine and Health, while for the Faculty of Arts & Social Sciences Peer Support and Self-paced training are the top categories with similar percentages (about 24-25%). Although the Faculty of Science shows a similar distribution with the Faculty of Arts & Social Sciences, Peer Support is seen to have a higher percentage (39%) compared to the corresponding one in the Faculty of Arts & Social Sciences (25%). An interesting distribution of responses was observed in the Faculty of Engineering where Self-paced training is by far the most popular post-training support method followed by Other Intersect training (both categories, taken together, constitute a percentage slightly higher than 60% of the total responses). It is worth noting that Other Intersect training was the most popular post-training support category for Law (43%) and Business (42%), while Self-paced training was the most popular category answered by respondents from Engineering (37%) and Architecture, Design & Planning (50%).

When considering different technologies, Peer Support was found to be the top answer (with a percentage between 32% to 45%) among survey respondents who attended a training course in MATLAB, NVivo, R and SPSS. Interestingly, self-paced training was very low in tools/technologies such as REDCap (4%), Qualtrics (6%) and HPC (8%) possibly due to the limited number of available training resources. When comparing the distributions of respondents for the programming languages, such as Python, R, and MATLAB, many differences were revealed. Peer Support was observed to be the highest in MATLAB (44%) followed by R (35%) and to a lesser extent Python (24%). Participants of Python courses preferred to attend Self-paced training and Other Intersect training after attending an Intersect training course (59% when combined). In regards to the surveying tools (REDCap and Qualtrics), the training participants have utilised the eResearch Analyst support the most among all tools/technologies with 41% and 30%, respectively. Peer support is the second most popular post-training support category followed very closely by Other University Services. When combining the eResearch Analyst and Other University Services, 59% and 51% of participants of REDCap and Qualtrics courses received further support after an Intersect training. This suggests that participants seek advice predominantly from REDCap and Qualtrics experts either from Intersect or University services. Post-training support provided by Other University Services was mostly used among HPC (38%) and Unix (35%) followed to a lesser extent by Qualtrics (20%), SPSS (20%), and REDCap (18%).

3.6 Link between research outputs and researcher digital skills training

A final aim of the survey was to capture any link between research outputs, such as journal articles, presentations, conferences, reports, *etc.*, with the knowledge acquired in Intersect training courses. This was a major factor in choosing to send the survey to participants who had attended Intersect training one year prior: allowing adequate time for application of the skills acquired in training to translate into the production of research outputs. The survey focused on widely used categories for research outputs as options in the following question to capture the relationship between research outputs and the knowledge acquired in Intersect training courses:

"Did the knowledge acquired in the [course name] course contribute to your ability to produce materials that led, or may lead to, any of these following research outputs? (Select all that apply)"

Approximately 79% (four out of five) of survey participants responded that the knowledge acquired in the Intersect training course contributed to their ability to produce materials that led, or may lead to, at least one of the research outputs. **This strongly indicates that the tools and technologies as well as the concepts and topics covered in Intersect training catalogue have become an integral part in the vast majority of researchers' workflow and are closely related with researchers' ability to produce research outputs!**

The participants reported that the knowledge they acquired during an Intersect training course directly contributed to their ability to produce a research output most frequently in the form of a Journal Article or Thesis (taken together, these two outputs constitute about 41% of the responses). Presentation and Conference make up around 15-16% of research outputs, respectively. Report and Poster are another two popular research outputs but to a lesser extent.

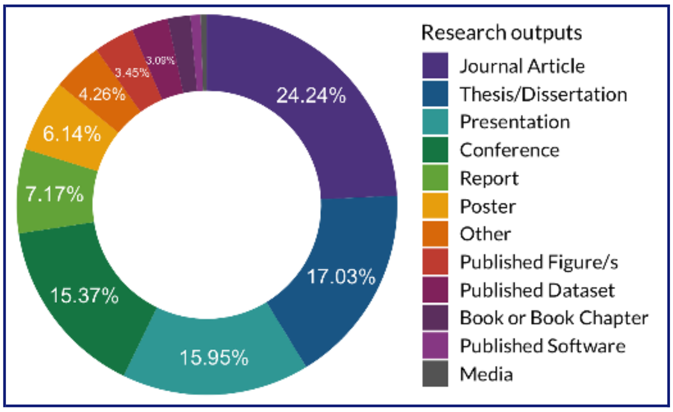


Figure 3.6.1: Distribution of responses about the link between the knowledge acquired in the Intersect course and the ability to produce research outputs.

Further analysis was carried out by Role/Position and Faculty for the top six research outputs that constitute about 86% of the total responses. Post-doc/Fellow, Academic, and Professional staff reported that the knowledge acquired in an Intersect training course contributed to their ability to produce a Journal Article in over 32% of responses. Contribution to Journal Article and Thesis were similar for both Higher Degree Researchers PhD and Masters, constituting combined 51% and 45% of responses, respectively. Conference and Presentation was the second (23%) and third (20%) most popular research outputs for Post-doc/Fellow while the opposite was observed for Academic, *e.g.*, Presentation (22%) and Conference (18%). The highest percentage for Report was seen in Professional staff (19%) while for Poster it was in HDR Masters (12%).

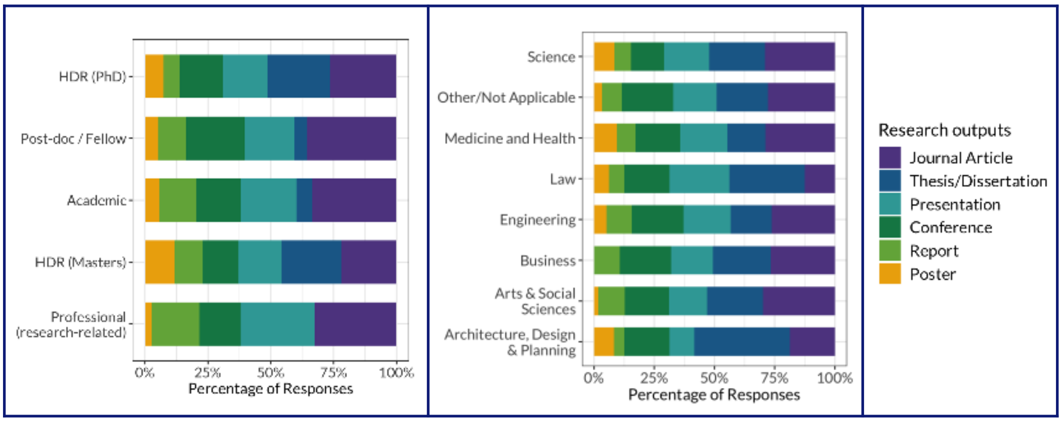


Figure 3.6.2: Distribution of responses about the link between the knowledge acquired in the Intersect course and the ability to produce research outputs (top 6) further split by (Left) Role/Position; (Right) Faculty.

The Journal Article research output was found to be the most popular among all faculties (between 26% and 30%) except for the Faculty of Law and the Faculty of Architecture, Design & Planning where Thesis/Dissertation was the most popular research output reported with about 39.6% and 31.3%, respectively. A few differences can also be seen in the top four faculties, namely Faculty of Medicine and Health, Faculty of Science, Faculty of Arts & Social Sciences, and Faculty of Engineering. While Thesis/Dissertation was the second most popular research output for the Faculty of Science (23.2%) and Faculty of Arts & Social Sciences (23.1%), Conference (21.4%) was the second most frequently answered research output followed closely by Presentation (19.7%) for the Faculty of Engineering. Researchers from the Faculty of Medicine and Health responded that Presentation (19.5%) and Conference (18.6%) are the second and third most popular research outputs related to the knowledge acquired in the training course.

Figure 3.6.3 shows the sankey diagram of the flow from Research Output to Faculty and then to Technology. Comparing the flow diagram (centre node percentages in Figure 3.6.3) with the distribution of survey responses by Faculty (Figure 3.2.2), only the Faculty of Medicine and Health shows a slight increase in the percentage of total research outputs produced (41.4%) compared to the percentage of survey respondents (37.3%). All the rest of the faculties show a decrease with the highest being in Other/Not Applicable and Faculty of Engineering. Therefore, the ratio of research outputs per faculty researcher was the highest for the Faculty of Medicine and Health. If we now compare the flow diagram with the distribution of survey responses by Tool/Technology (Figure 3.2.1), we can find some interesting insights. Notably, the highest increase in the percentage of total research outputs compared to the percentage of survey respondents is shown in the surveying tools, REDCap (21.9%) and Qualtrics (20.1%), followed by Excel (9.7%), SPSS (9.6%), and R (4.2%). On the other hand, the highest decrease is observed in Python (-29.1%) and MATLAB (-21.7%). When taking into account the flow of research outputs from Faculty to Technology for the two most popular programming languages, R and Python, we observe that the biggest cohort of researchers using R to produce research outputs are the Faculty of Medicine and Health with 51.2% and the Faculty of Science with 33.7%. On the contrary, researchers who use Python to produce research outputs are mainly from the Faculty of Engineering (38%) and the Faculty of Science (33.5%). In regards to the surveying tools, the vast majority of REDCap users who produce research outputs are from the Faculty of Medicine and Health with 71.2% and to a lesser extent from the Faculty of Science (16.1%). Interestingly, Qualtrics shows a different pattern where a similar proportion of researchers from the Faculty of Medicine and Health and the Faculty of Arts & Social Sciences with 33.5% and 26.6%, respectively, (followed by the Business School with 13.3%) responding that the knowledge acquired in a Qualtrics course helped them produce research outputs. Excel is another interesting case where the Faculty of Medicine and Health predominantly used it to produce research outputs (46.8%) followed by the Faculty of Science (17.8%), Faculty of Arts & Social Sciences (12.6%), and Business School (12.3%). SPSS was mainly used by the Faculty of Medicine and Health (46.7%), however the Faculty of Arts & Socials (19.1%) and the Business School (15.2%) also used SPSS to produce research output with a percentage of 34.3% when combined together.

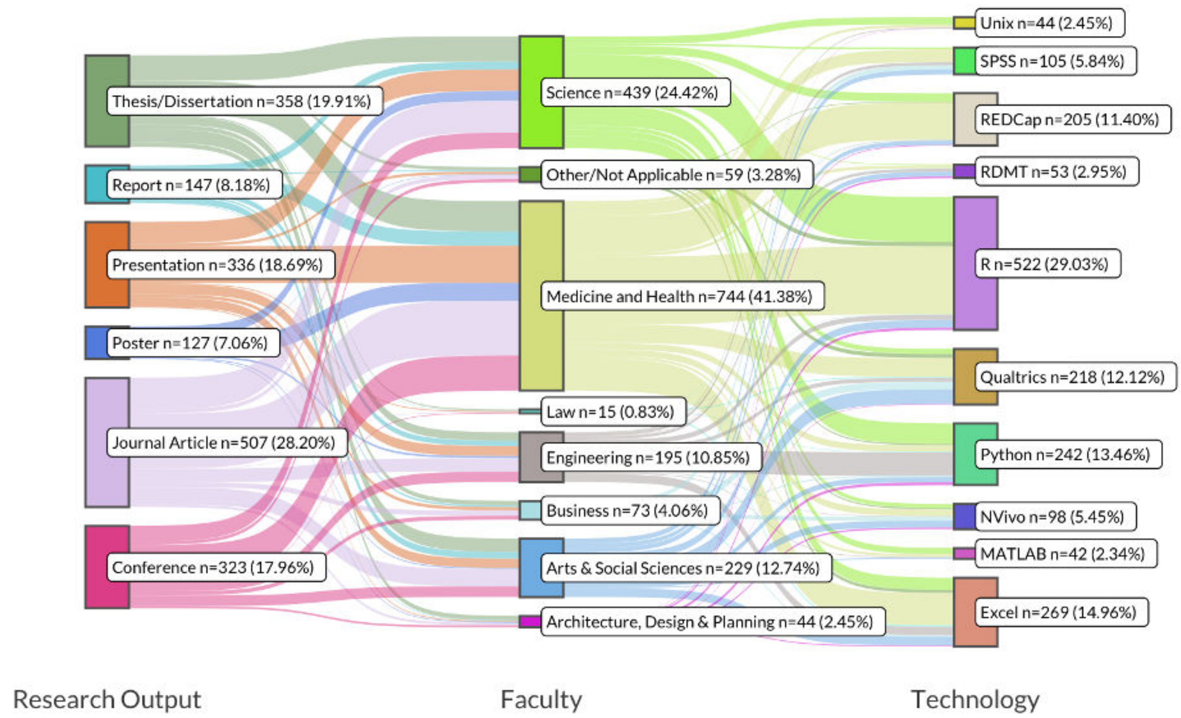


Figure 3.6.3: Sankey diagram depicting the flow from the top six Research Outputs to the different Faculties and then to the top 10 Tools/Technologies.

Based on Figure 3.6.4 where we present the sankey diagram from Research Outputs to Role and then to Technology, interesting insights can be noticed. Academics responded that REDCap (33.3%) and Qualtrics (27.4%), and to a lesser extent R (11.8%), Python (11.8%), and Excel (10.8%) were the tools that they mostly use to produce research outputs. R, Python and REDCap with 35.2%, 21.7% and 17.8%, respectively, were the most popular tools used by Post-docs/Fellows to produce research outputs. HDR PhD students predominantly used R (30.7%) to produce research outputs followed by Excel (14.3%), Python (13.1%), and Qualtrics (11.9%). NVivo, REDCap, and SPSS were also used by HDR PhD students but to a lower degree with a percentage between 6% and 7.5%. Notably, compared to HDR PhD students, Excel was largely used by HDR Masters students to produce research outputs (44.3%) followed by R (21.7%) and REDCap (11.3%).

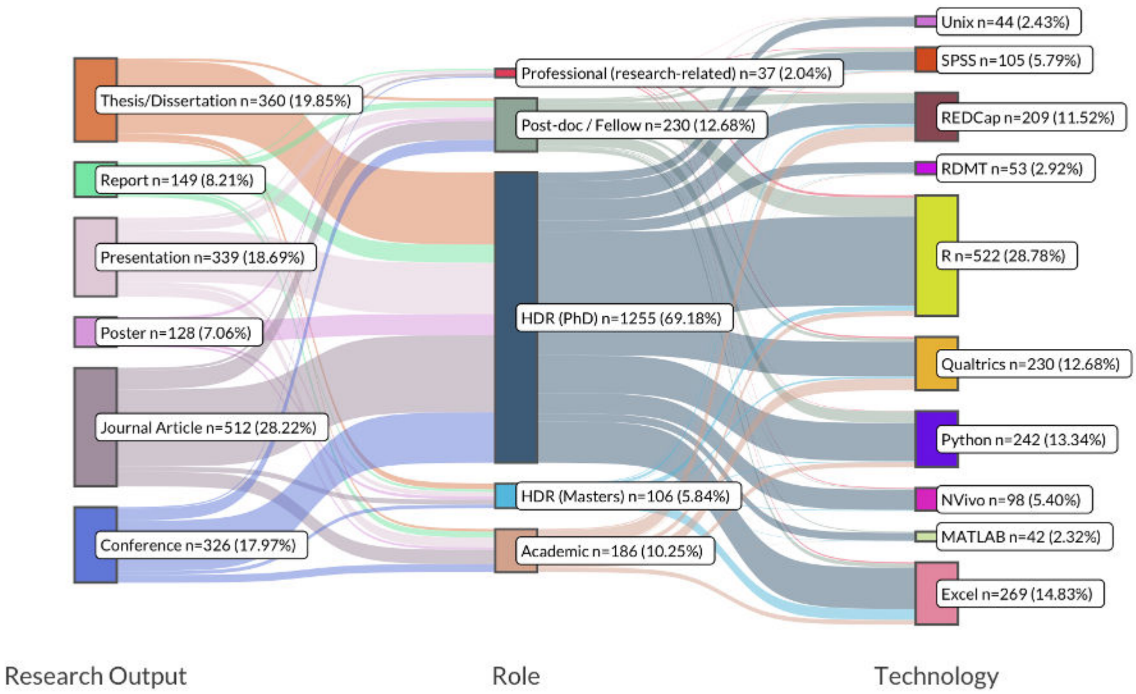


Figure 3.6.4: Sankey diagram depicting the flow from the top six Research Outputs to the different Roles/Positions and then to the top 10 Tools/Technologies.

The flow chart from the different Roles/Positions to the various Faculties and then to the top six Research Outputs is shown in Figure 3.6.5. The largest portion, 54.5%, of Academics who produce research outputs using the digital tools/technologies mentioned in this report are from the Faculty of Medicine and Health followed to a smaller degree by the Faculty of Arts & Social Sciences (17.9%), the Business School (10.7%) and the Faculty of Science (8.2%). Post-docs/Fellows who use digital tools/technologies to produce outputs are mainly from the Faculty of Medicine and Health and the Faculty of Science with 55.5% and 24.6%, respectively. As for HDR PhD students, Faculty of Medicine and Health and Faculty of Science are the two predominant faculties with 36% and 26.7%, respectively, while Faculty of Engineering (13.9%) and Faculty of Arts & Social Sciences (11.4%) also constitute significant portions. It is worth noting that the Professional staff (research-related) who answered that the digital tools helped them produce research outputs are largely from the Faculty of Medicine and Health and Faculty of Science, which when combined together constitute about 89% of the total number of responses from this cohort.

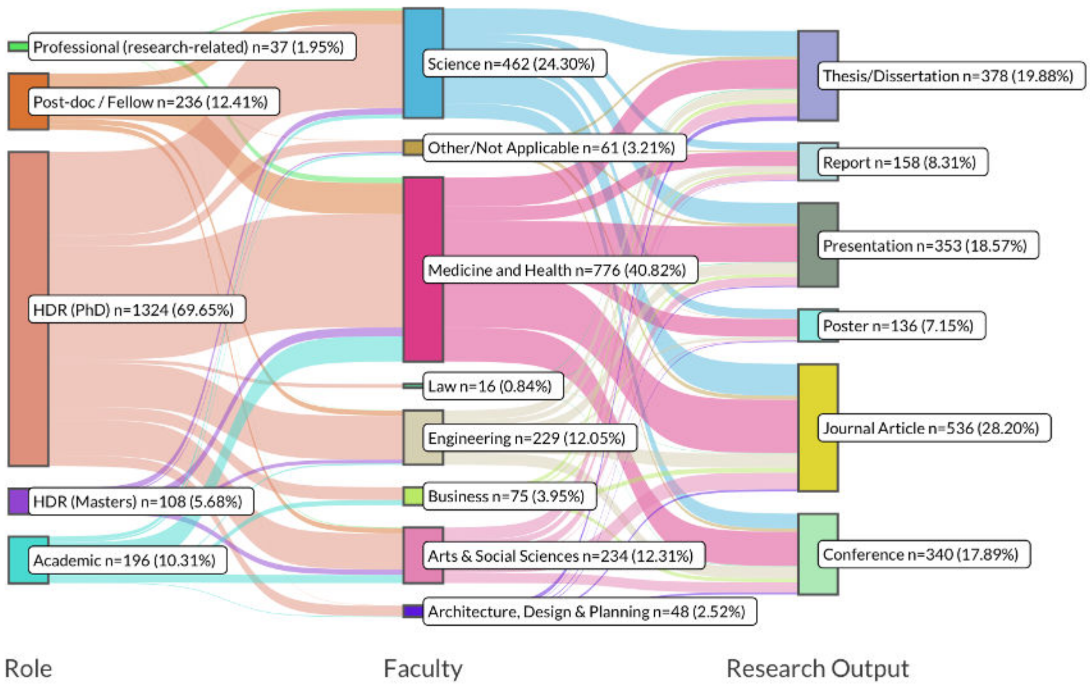


Figure 3.6.5: Sankey diagram depicting the flow from different Roles/Positions to the different Faculties and then to the top six Research Outputs.