Raising the status of software in research: A survey-based evaluation of the Software Sustainability Institute Fellowship Programme

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Abstract

This paper reports the results of an evaluation of the Software Sustainability Institute's Fellowship Programme, which focused on understanding the benefits that the fellowship has afforded its recipients. The evaluation took the form of a survey open to people awarded fellowships between 2012 and 2016, which asked people to report the effect that the programme had had on them, their institutions, their research domains and their careers. The results show that the fellowship plays a wide-ranging role in supporting communities of best practice and skills transfer, and that a significant benefit is the way it has raised the profile of software in research, and those people who develop and advocate for it.

Introduction

The Fellowship programme (Sufi) run by the UK Software Sustainability Institute is a unique programme of financial support, networking and advice, which is competitively awarded to members of the research software community. The programme offers £3000 to support event attendance, workshops, training and other activities to help build awareness, capability and capacity in computational techniques, reproducible research and open science in diverse research domains.

Fellows are selected via an open competition, where candidates are judged by a panel of experts (former fellows and Institute staff members) in terms of their track record in practising and promoting software sustainability, and the activities they plan to run with the fellowship award. To promote diversity, funding is allocated to people at different career stages (from PhD student to research leader) and a variety of domains (e.g. Glaciology, Research Software Engineering, Humanities and Engineering). The overall aim of the Fellowship programme is to provide support and recognition to those people promoting sustainable software practices, and advocating for and producing more verifiable, shareable and useful research outputs.

This paper reports the results of a recent survey evaluation of the programme's effects on its recipients and their wider communities. A thematic analysis of the results showed that the award of a fellowship had substantial and wide-ranging benefits both for the fellows themselves, and for their institutions and research domains. The theme that emerged most strongly and consistently was that the fellowship provided status to both the fellows themselves, and the role of software within research. Respondents reported that current academic culture does not always afford recognition to research software and research software engineers, and that the fellowship has played a key role in improving the visibility of this ubiquitous yet undervalued component of research methodology.

Method

The survey was conducted using the University of Manchester SelectSurvey.NET instance ("My Surveys") to ensure the data was collected and stored appropriately.

The initial part of the survey explained what the purpose of this research was and asked for consent from participants. Participants were asked if they would agree to participate, if they understood that participation was voluntary, by taking part they understood that they data would remain confidential, whether they agreed for retention and use of their data for future investigations around the Fellowship Programme and asked if they would allow anonymous

quotes. They had the ability to consent 'Yes' or 'No' to any of these questions. All participants who were used in the analysis answered 'Yes' to all of these questions.

They survey then went on to ask Fellows to comment on the benefits of the programme in a number of categories, and to report any negative consequences (see Table 1). The survey was sent to the entire population of the 2012-2016 Fellows (78 in total). The study received approval from the University of Manchester Research Ethics Committee.

Table 1: Survey questions and analysis performed

Question	Data
Do you think being awarded a Software Sustainability Institute Fellowship has benefitted you?	Forced choice response: Yes/No/Unsure
How has your Fellowship benefitted you?	Free text
How has your Fellowship benefited your Institution(s)?	Free text
How has your Fellowship benefited your domain?	Free text
How has your Fellowship benefitted others in ways not already covered?	Free text
Have there been any negative consequences of your Fellowship? If, yes, please specify.	Free text
Do you think being a Fellow has helped to advance your career?	Forced choice response: Yes/No/Unsure
If not already specified, how has being a Fellow helped in your career development?	Free text

Fellows were asked to provide information about gender, year in which their fellowship was awarded, which funding bodies supported their work and their research area. It also asked about their current job role, job role at the time the Fellowship was awarded, and specific research area, but this information is not reported here as the small number of participants means it may be possible to identify individuals from this data.

The free text answers were thematically analyzed in an open coding fashion following established analysis methods (Braun & Clarke, 2006): (1) familiarization with data, (2) generating the initial codes, (3) searching for themes, and (4) iteratively reviewing themes. The generated codebook was agreed between the authors.

Results

There was a response rate of 33% (N = 26). Seven fellows from 2016 responded, 8 from 2015, 6 from 2014, four from 2013 and one from 2012. One of the respondents (Caroline Jay) is an author of this paper, and her results have thus been excluded from the analysis, leaving a total 25 respondents.

Demographic information

Five respondents were female and 21 were male. Table 2 shows the funding bodies that supported the respondents' research.

Table 2: Funding sources of the respondents' research. The centre column shows the number of respondents listing the body as their primary funder. The right hand column shows the number of respondents listing the body as an additional funder.

Funder	Primary	Secondary
EPSRC	3	3
BBSRC	2	3
NERC	3	1
AHRC	1	3
ESRC	1	2
MRC	1	2
STFC	1	1
Commission/ERC/European Space Agency)	3	5
NIH	1	0
Wellcome	0	7
Internal/employer	5	0
Leverhulme	0	3
Any/Various/Other	0	9

Forced choice analysis

In answer to the question, 'Do you think being awarded a Software Sustainability Institute Fellowship has benefitted you?' 96% (n = 24) answered 'yes'. One person answered 'unsure' and zero people answered 'no.'

In answer to the question, 'Do you think being a Fellow has helped to advance your career?' 72% (n = 18) answered 'yes,' 16% (n = 4) answered 'no' and 12% (n = 3) answered 'unsure.'

Free text analysis

The first author coded the dataset into a number of initial themes. These were grouped into overarching themes by the second author, which were then used as a codebook for the answers to

the questions 'How has the fellowship benefitted you/your institution(s)/your domain/others?'. The results were checked by the first author for agreement. The emergent themes are described in the bulleted list below.

- **Status**: giving status and recognition to individuals and organisations for their role in sustaining software, and to sustainable software practices themselves.
- **Community/network**: organizing/attending events; building professional and personal networks.
- **Professional development**: improving one's own skills through undertaking training and improving the skills of others by providing training.
- **Resources**: obtaining resources for travel and other professional activities.

Table 3: Number of respondents reporting a benefit under each theme for the various question categories.

Theme	Self	Institution	Domain	Others	Total
Status	20	4	4	3	31
Community/network	13	10	3	1	27
Prof development – self	11	2	4	0	17
Prof development – others	3	10	9	4	26
Resources	6	3	3	4	16

Table 3 shows the number of respondents who reported a benefit under each theme for the categories that the questions asked about: self, institution, domain and others. In the following sections we explore each of these themes in turn.

Status

Across the questions, 31 comments were made in relation to the fellowship leading to an improvement in "profile and prestige" (R5). The majority of these (20) were in relation to improving the status of the individual fellow.

The impact on the Fellows' status manifested itself in a number of ways, including: giving them recognition as someone who knew about software sustainability and good coding practices; providing a badge which opened doors and allowed them to market themselves; and becoming more appealing as collaborators at the institutional, domain and interdisciplinary level. Four respondents reported that having a Fellow raised the profile of a department or institution. Table 4 illustrates the impact of the Fellowship on status with quotations.

There was evidence that the credibility conveyed by the Fellowship contributed to the Institute's mission to improve diversity ("Women in software | Software Sustainability Institute"): "*Despite getting a PhD partially from a computer science programme, I could see that my skills and knowledge were always at least to some extent dismissed or doubted. I do not want to speculate whether this is due to gender bias or some other prejudice-based process or my own failing at looking professional, but since being elected a SSI fellow I most definitely observed a significant drop in mansplaining."* (R11).

127 *Table 4: Responses illustrating the impact of the fellowship on status*

Question	Response
How has your Fellowship benefitted you?	*"The opportunities this has given me are huge in terms of connections and invitations to speak at international conferences and to participate in workshops, review panels etc. All this external work has been particularly noted in my performance reviews and I believe it was crucial in helping to secure a recent promotion."* (R24) *"It has given me credibility locally as an expert in good coding practices, open data and code, and publishing… It has made the department recognise my role in facilitating others' research and to be recognised as a pivotal enabler in ***[1] research."* (R4) *"I think it has opened a lot of doors. I almost always tell researchers that I talk to about my links to the SSI, as an indicator of my standing in the wider community. I am fairly sure that I have been invited to at least two major events due to my SSI links, and these have lead to on going research."* (R25) *"It helped me build my reputation within the field of digital humanities and to be a leader in sustainable thinking. It helped get me a position on the *** technical review board"* (R3)
How has the Fellowship benefitted your institution(s)?	*"[It provided] strong recognition for my institution's research IT organisation as being a leader in development of research software engineering services.*" (R22) *"I think most of the benefits to me translate to my institution as well, as it helps me to do my job - status, meeting people, etc."* (R24) "*Collaborations that I developed through the fellowship have indirectly benefited my institution by kudos from the research that was produced"* (R14) *"During my fellowship I have raised awareness of the wider UK RSE community in my institution. My institution has a strong background in research software and has a high level of self sufficiency. I believe that improving the interaction with the wider community will benefit our organisation and others."* (R20)
How has your Fellowship benefitted your domain?	*"Probably not my fellowship, but if we consider all fellows in or close to my domain, I think together, we have had a global impact.*" (R2) *"It has helped to get a better attention of our team by all the other researchers in the university."* (R13)

[1] *** indicates removed to preserve anonymity

How has your Fellowship benefitted others in ways not already covered?	*"I believe the Fellowship has helped to create a movement of Research Software Engineers, which I believe is helping to give recognition to the importance of good practice in software development within research institutions. Giving recognition to robust software development (including software for data analysis) is crucial to improve the quality and reproducibility of published research."* (R1) *"I'm quite well known in various areas (***), and I believe that my frequent talking about the issues of reproducible software and scientific software in general raised awareness of both these issues as well as the SSI."* (R8)

Community/network

Fellows benefitted from joining a community of like-minded individuals and the networking opportunities that arose from this. Respondents made 27 comments in relation to the Fellowship improving their network, 14 of which showed that this benefit went beyond themselves, to improve the software research communities within their institution/domain. R24 said: *"The fellowship has been hugely beneficial to me and my career. The contacts and collaborations formed during my fellowship year have led, directly and indirectly, to a huge number of opportunities."* The benefits included increasing confidence; feeling part of the research software community and not an outsider; sharing good practices; being able to identify as a Research Software Engineer (RSE) and supporting their role in formulating RSE community of practice via the RSE Association ("Research Software Engineers Association").

Respondents reported that the Fellowship gave them the mandate to collaborate with different organisations and institutions, as well improving the local networking of those involved with research software. Three Fellows at one institution were able to work together.

Fellows from a single domain expressed that a number of them working with each other across years had a cumulative effect over time, in effect seeding a hub of researchers/fellows who took sustainability seriously. There was a platform for them to then influence domain specific groups at different institutions increasing the impact and reach of promoting better sustainability practices. Fellows felt motivated to collaborate, form online communities, and contribute to the open source community.

The Fellowship ultimately provided community, friendship and motivation for new ways of doing things. The Fellowship also helped them become better scientists and ambassadors for sustainability issues in their community and thus better recognised.

Table 5: Responses illustrating the impact of the fellowship on community/network

Question	Response
How has your Fellowship benefitted you?	*"Huge range of contacts with interesting people"* (R14) *"Meetings and interactions with other fellows made me better at programming, understanding issues related to software."* (R19)

	"Great access to national leadership in e-Infrastructure and scientific software, increasing my influence, and enabling me to advance my career." (R22)
How has the Fellowship benefitted your institution(s)?	*"The Fellowship covered the costs for a research engineering expert to visit my laboratory and to provide guidance on various aspects of software development to colleagues. I believe this guidance strongly influenced my colleagues to move to better quality, more collaborative software development practices."* (R1) *"Because of my fellowship, I got involved in other computational reproducibility groups, which have benefitted my institution in both publications and expertise brought back.*" (R15) *"It has added to their portfolio of cross-discipline interaction."* (R12)
How has your Fellowship benefitted your domain?	*"It allowed engaging with the community about issues of data sharing standards and good coding practices."* (R19) *"I've had the chance to speak about research software sustainability and RSEs to lots of different audiences in the fusion community, other large experimental facilities and to Physics PhD students at careers events" (R23)*
How has your Fellowship benefitted others in ways not already covered?	*"I have set up a code club in my children's school"* (R11) *"I could link some people to women in HPC and to the SSI."* (R17) *"Friendships with like-minded scientists and scholars, really help me to believe that the a way of doing things is not just a personal idiosyncrasy but a real wave of change across research. The existence of a community of open-science, reproducibility, research software engineering, new science metrics, and post-postdoc career innovation types is great for motivation"* (R22)

Professional development

Respondents stated that the Programme had helped them to progress in their careers, either by way of a new job, promotion, or change in direction: "I can map my entire career trajectory from the opportunity that the fellowship gave me. One meeting led to another..." (R11).

In answer to the question, 'If not already specified, how has being a fellow helped your career progression?' three respondents mentioned gaining confidence, three mentioned improving skills, 7 mentioned improving their networks, and five mentioned improving their visibility. The programme had a significant effect for R24: "The fellowship, and then all the external collaborations and followed from it, have been directly cited as reasons for giving me top performance ratings over the last three years… Without this community of like-minded people to

engage with I'm not sure I'd still be working in the same organisation, or even in research software at all."

Across the other questions, 17 comments related to professional benefits for the Fellows themselves that included: improving personal knowledge and practices; understanding how much of research is software driven; developing a habit for research related blogging; identifying new areas in their own research fields; and thinking about research software development as a career. Fellows increased their confidence in research software development, and they were able to get career, technical and other advice from other Fellows, mentors, institute staff and others they had met at workshops.

The Fellowship awards had an even greater impact on the professional development of others, with 26 comments relating to this altogether. Fellows ran training courses, such as software carpentry, and spread best practice via workshops, and supported data sharing and reproducibility initiatives. Table 6 illustrates the impact of the Fellowship on professional development with quotations.

Table 6: Responses illustrating the impact of the fellowship on professional development – self

Question	Response
How has your Fellowship benefitted you?	*"After I got the fellowship, the department (***) has set up a code clinic, where I troubleshoot people's coding issues for half an hour a week. They are also planning hire me in December to give the same Good Coding Practice seminars that I prepared as part of the fellowship, to the department as a seminar series."* (R4) *"It has given me a much greater understanding of the roles of software in academia."* (R10)
How has the Fellowship benefitted your institution(s)?	*"Forty physicists and engineers took part in the Software Carpentry workshop in late 2015 and had training in Python, Linux command line and Git. This would not have run without the fellowship funding and was very well received. Members of my team who were helpers at the event are now using the training materials to deliver smaller internal workshops on the three topics and bringing in further helpers, so we are on the way to having a pool of trainers."* (R24) *"I was able to deliver the good coding practice seminar to the British Neuroscience Association (2017) to an audience from around the country, of scientists who regularly code as part of their research. I received exceptionally positive feedback from the seminar."* (R5) *"Because of the external funding, visiting PhD students were able to attend the Software Carpentry workshop and take their skills back to their University groups."* (R25). *"My fellowship supported a Software Carpentry Instructor Training session in my institution. This training will help staff in my organisation*

	create and deliver better development material focused on scientific software development" (R20)
How has your Fellowship benefitted your domain?	*"Library Carpentry has had a MASSIVE impact in librarianship. *** has benefited from 3 fellows (including me)."* (R7) *"Fellowship funds were used to hold a computing workshop for early career *** scientists in the UK."* (R15) *"It has afforded people within my research domain the opportunity to learn a range of different software packages for 3D reconstruction for free - which is a really valuable opportunity when many people have limited, say PhD funding."* (R21)
How has your Fellowship benefitted others in ways not already covered?	*"I have given two extended workshops on agent-based modelling to archaeologists thanks to the fellowship funding. A number of students who participated have shifted their research interest into simulation and a vast majority of participants agreed that even if they will not pursue this line of research further they have enough knowledge to be able to critically engage with published models*" (R10) *"I believe the Fellowship has helped to create a movement of Research Software Engineers, which I believe is helping to give recognition to the importance of good practice in software development within research institutions. Giving recognition to robust software development (including software for data analysis) is crucial to improve the quality and reproducibility of published research."* (R1)

Resources

Fellows used the £3000 award for attending conferences and workshops that they normally would not be able to; organising events; running training; kick-starting an initiative (such as a product, service or approach); and inviting visitors. Although not everyone used the funds: "My position is probably different to many fellows in that I mostly wanted to be a fellow to show support for the SSI and the fellows network/community and to highlight the importance of this area in my institution. Access to funds wasn't a consideration" (R4), across the respondents they supported a wide range of activities, summarised in Table 8.

Table 7: Activities that respondents reported were made possible using the Fellowship award.

Activity	Number of respondents	Response
Attending event	6	*"I was able to use the balance of my fellowship funds to attend a conference in the US that I would not normally be able to."* (R26) *"Data sharing in critical care is still in its infancy, but*

		thanks to support from the Software Sustainability Institute colleagues in London were able to host a datathon to promote reproducibility and data sharing in critical care, as well as to share a critical care dataset." (R1)
Organising event	9	*"Forty physicists and engineers took part in the Software Carpentry workshop in late 2015 and had training in Python, Linux command line and Git. This would not have run without the fellowship funding and was very well received."* (R25)
Project funding	3	*"I started as a fellow whilst I was a post doc. The fellowship provided me with really useful independent funding to pursue a line of work and interaction that was not covered by my postdoc funding."* (R12)
Hosting visitor	2	*"I was able to fund the travel/accommodation for a keynote speaker to a workshop who ended up being absolutely perfect for the event. Without the fellowship funding I don't think I would have been able to secure her trip."* (R12) *"The Fellowship covered the costs for a research engineering expert to visit my laboratory and to provide guidance on various aspects of software development to colleagues. I believe this guidance strongly influenced my colleagues to move to better quality, more collaborative software development practices."* (R1)

Negative consequences

In answer to the question, 'have their been any negative consequences of your fellowship?' 14 people said there had not been anything negative, and 7 people did not give an answer. One person commented that they sometimes had to explain that software sustainability was not the same as digital preservation, and that this disappointed the person they were talking to. Three respondents gave lighthearted answers: "I definitely spend more time on Twitter because of you guys!" (R9); spending time "struggling with installing and implementing open source software (just kidding, though it takes time, I thoroughly enjoy learning new things, and it's an investment in the future)" (R10) and "a lack of time to take advantage of all the opportunities – not a bad problem to have!" (R22)

Although the Programme itself did not appear to result in negative consequences, R19 commented that their institution "was not interested in [the Fellowship] at all."

Limitations

The study focused on the benefits of the Fellowship Programme. We chose to use the word 'benefit', rather than 'impact', because we wanted people to reflect on the potential positives that came from the Fellowship in the broadest terms. Whilst the authors did not anticipate that the Fellowship would result in many negative consequences, and a question checked for these

explicitly, the phrasing of the questions could have biased respondents towards seeing the Programme in a positive light. The survey only captured the responses of a third of Fellowship holders, so we do not know the experiences of the remaining two thirds. The first author, Shoaib Sufi, is employed on the Institute grant, and the second author, Caroline Jay, is a Fellow; both therefore have an interest in the Institute.

Conclusion

The survey evaluation has shown that the Fellowship programme has played a significant role in supporting and galvanising engaged people in contributing to the domain of research software engineering. The gains in community building, networking, individual status, individual learning and the development of others, leading to long term benefits, initiatives and communities of practice are significant given the modest investment. Seed corn funding approaches are noted as being particularly effective mechanisms of support (The Royal Society et al.). The evaluation of the programme has shown the need to support research software in situ and credit the engineers and researchers who are working in this important area that supports reproducibility, reuse and the integrity of research investments.

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