POSTDOCTORAL AND EARLY CAREER RESEARCH WORK FOR FURTHER LEARNING AND INDEPENDENCE

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ABSTRACT

As an extension of PhD research training, postdoctoral or early career research work is essential in physics, leading to enhancement of research skills and learning of skills required in academia. Through interviews with ten postdoctoral and early career researchers, we explore their expanded and further learning and training towards being independent researchers who can create higher knowledge and skills in physics.

KEYWORDS

physics – research training – postdoctoral work – early career.

INTRODUCTION

There is a high level of international employment mobility in the field of physics (Vlachy, 1981a, 1981b). In fields such as physics, postdoctoral work—typically a minimum of 2–3 years of research, virtually a second PhD without a thesis—is a de facto prerequisite for long-term employment in academia. Where research employment is dominated by the universities, it can be the only path along which the graduate can attempt to remain in the field of their doctoral study. Due to the lack of research academic positions and high competition for employment in physics, it is not unusual to find researchers with six or seven years of research work experience working in a second or third consecutive postdoctoral position, or in other short-term academic positions. These relatively experienced, as compared with recently graduated postdocs, researchers can be counted as early career researchers (ECR) in academia. (Akerlind, 2005; Thompson, Pearson, Akerlind, Hooper, & Mazur, 2001).

Role expectations for postdocs are not universal, depending on disciplines and countries (Musselin, 2004). Their actual research work experiences vary from providing day-to-day technical support for other researchers through to fully independent research, depending on their supervisors and research circumstances. In Australia, postdoctoral work almost always consists of fixed-term research-only positions, usually at academic levels A (associate lecturer) or B (lecturer), equivalent to ECRs, below the senior C (senior lecturer), D (associate professor), and E (professor) levels in Australian universities. As junior faculty members, postdocs are involved in various research, teaching, and related administrative duties in academic practice (Thompson et al. 2001).

While the prevalence of short-term postdoctoral work certainly appears to depend on the short-term nature of much of the available research funding, postdoctoral and early career researchers (ECR)—at least those likely to remain active researchers—can demonstrate significant improvement in their research skills, including the ability to work productively in a team environment, preparation of requests for research funding, and the pursuit of further funding as well as teaching and supervision (Musselin & Becquet, 2008).

As there are no curricula for postdoctoral research workers, the level to which deliberate training is systematic is highly variable, from being non-existent, with the worker essentially left to self-train, to structured mentoring programs (Thompson et al. 2001). The distinction between doctoral and postdoctoral learning and research training is important for an understanding of the postdoctoral experience. We will present postdoctoral fellows' views and experiences based on their past research training experiences during their postgraduate studies in physics. This allows us to gain valuable insight into international views on research training, postdoctoral work in the discipline of physics as further research training, and attitudes towards research and academia across a broad international spectrum.

Academic physicists as lifelong learners

Physics research needs a range of scientific technical skills, either theoretical or experimental, and it is important for success to maintain the currency of, and to improve, such skills. From the viewpoint of basic technical abilities, a commitment to ongoing learning to solve problems, often associated with technical skills, is required. Perhaps more fundamental, physics research is driven by intellectual curiosity and desire for understanding about the world and universe (Benka, 2006)—physics research is largely the quest for learning through investigating the world and phenomena of interest, and developing further knowledge,

including improved theories and models of phenomena, and new experimental techniques. Research careers of academic physicists are driven and rewarded by peers' professional recognition about their scientific accomplishments (Merton, 1973), so this is often of great personal importance. The learning of the required technical skills dominates the undergraduate and doctoral training of physicists, but is expected to continue throughout their careers. It should also be noted that work in academic physics requires other academic skills beyond technical research skills: teaching, supervision, management, working in teams, and so on. An academic physics career may be differentiated on the continuum of learning experienced by students, as they progress from undergraduate studies, through postgraduate research work, to postdoctoral work, as developing more and higher skills and knowledge than before (Jarvis, 2004).

METHODOLOGY

Ten early career academics—eight postdocs and two early career researchers (ECR) with recent postdoc experience, of international origin from Europe, Asia, and South America—were interviewed about their postdoctoral academic experience in a research-driven university in Australia. One was female, and nine male. Ages were from 28 to 40. They had spent from six months to four years in Australia. Interviews were face-to-face and semi-structured. For example, they were asked to: distinguish their postdoctoral research work from their PhD work; and describe their current postdoctoral work in Australia and compare their current work with previous employment or research experience. They were recorded and transcribed, with interviewees approving the final version of the transcripts. Transcripts were analysed using thematic analysis (Braun & Clarke, 2006) focusing on the similarity and difference between postodoctoral work and PhD study on the basis of their personal learning experiences and perspectives on the job.

RESULTS AND DISCUSSION

Since the interviewees held postdoc or ECR positions essentially transitional between those of doctoral students and academic physicists, it was not surprising to find that postdoctoral learning experiences were also transitional, moving beyond the straightforward acquisition of scientific knowledge and technical skills, to a greater focus on learning to be independent researchers. Below, we outline the major elements of the postdoctoral learning experiences of the interviewees.

More independence and self-motivation

During PhD research training, a student's project is often a part of a larger project of the supervisor's team. This is common in science but much less so in social science and humanities (Delamont & Atkinson, 2001). In physics, postdoctoral work is clearly distinguished by greater independence and responsibility than during the PhD, with less dependence on the skills of supervisors. Postdocs can be expected to publish more, with less input from the rest of the team. To do that, self-motivation is an important factor for postdocs affecting their research performance.

> *…working towards your PhD is basically, you're working under your supervisor's wing. So, basically, you just have to be a good spokesperson for your supervisory research… Basically your supervisor tells you, okay, do this and this and this… But, working as a postdoc is different ball game. Whole different ball game (Postdoc 2)*

> *...I have to be more self-motivated. Otherwise, it's just, I can't do anything… There is no one who forces me to do this, or that (ECR 4).*

> *Probably they expect more from a postdoc… The last publication of my PhD, I did more by myself. My supervisor looked at it, put his name on it and sent it off. He gave some comments. What I expect to change is that at the PhD level, people tell you what's an interesting topic, and that you should work on it. But now, they expect me to come up with that myself (Postdoc 9).*

Developing broader perspectives

Developing broader perspectives and exploring new research areas are further expansions of learning in postdoctoral work from technical learning with a short-term focus that dominates PhD training. During the PhD work, they were generally asked to solve problems involving mathematical or technical skills. To solve the specific problem, they were not necessarily required to have broader view about the project. PhD students often play technician roles that require strong attention on the solution of particular problems. During postdoctoral work, however, they are expected to develop broader research perspectives and come up with new ideas—postdocs are expected to play a role as beginning scientists, creating scientific knowledge, rather than only learning existing scientific knowledge and working as a technician.

…PhD should work to make the experiment happen, finding a short-term perspective for his experiment or his research line… the postdoc should start thinking about what's around the corner, and the PhD should think about how to reach that corner. Doing a PhD is more about technical attitude… The postdoc should start to think about what's next… The postdoc should surely work to make it happen, but also to give a broader perspective and new ideas. But these new ideas shouldn't be limited to new experiments. You can do new calculations; you should aim to give new ideas from which new research can sparkle (Postdoc 7).

A bridge between supervisors and postgraduate students

A student's PhD study is for his or her own learning. He or she has no responsibility to look after others' learning. Having interim positions, the postdocs or ECRs can be a bridge between supervisors and postgraduate students, with responsibility for others' work, including helping postgraduate students' learning. Particularly for busy supervisors with high demands placed on their time by teaching and administrative duties, postdocs and ECRs take a responsibility for others' work. Through this role, they have more opportunities to learn about physics as an academic discipline.

…You must be at some stage a supervisor for students, because you are a bridge between the lab and the supervisor… he [supervisor] can not always be inside the lab, so at this point, find literature, try to find new problems, and solve the problems you are working on now (Postdoc 6).

In your PhD, you're responsible for your own work; now you're responsible for other people's work… you have to worry about more, the grants and sufficient publications, and stuff. To keep the group going, to keep the experiments going, and to get the grants… Which you're not concerned about when you do your PhD…you just have to do research (Postdoc 3).

Writing research grants

The demonstrated ability to attract research grants or other funding is a key requirement for academic employment or promotions in research-driven universities (Boyer & Cockriel, 2001). In physics, postdocs and ECRs are often employed on research grants, and due to the limited research budgets available, obtaining such employment can be highly competitive In Australia, postdocs and ECRs can be involved in research grants in both direct and indirect ways. Directly, prospective postdocs or ECRs can apply as chief investigators for funding from research grants schemes, including individual university operated ones as well as Australian Research Council and National Health and Medical Research Council schemes. In this way, postdocs and ECRs can create their own (short-term) positions and are typically key stakeholders in such projects. Less directly, academic staff can obtain research funding, including salaries for postdoctoral researchers, and advertise the positions. Especially for the former path, it is essential to learn to write successful research grant applications, which often heavily depends on assistance and support by the supervisor, comparable to the way in which fundamental technical skills are learned during the PhD. Considering the highly competitive nature of research grants in Australia (Yates, 2006), this learning about grant writing is vital for physicists who wish to stay in academia and develop their careers.

Yes, it is part of the administrative life, to attract funding for your projects, to try to attract funds from funding agencies… I think they [postdocs] have to do that. It's important because, again, it's another learning stage of your life. When you get a permanent position, you have the knowledge to write a project, to know how to ask for money, how to attract funds. So it's good to do it now, because you have a supervisor to correct your work. Then after you have got a permanent position, you don't have anyone to help you. So it's very good to do it now, to correct mistakes and so on (Postdoc 6).

Intellectual and physical challenge

In physics research work, learning and knowledge creation take not only intellectual but also physical demand. For example, when postdocs or ECRs involved in various experiments, this demand is higher because experimental work is unpredictable with from small to big scopes of problems. Either to prevent or solve the problems, experimentalists in postdoc or ECR positions have to prepare themselves. It can cause tiring and frustrating. However, they take this challenge in a positive manner, satisfying. Individual satisfaction by learning more or new through solving the challenging difficulties drives work performance.

…it's my first postdoc, and I would define it as 'tiring'…There's lots of work to do, but I'm happy like this. It's satisfying. Very tiring and satisfying… As a postdoc, if you get something going well, here, surely

something is going wrong in another place. And you have to move there, and solve the problems. And so, it can be frustrating, because there are always troubles going on. On the other hand, it's more satisfying, because you're not only working on your project, it's the work of the entire group that's going on. And you feel that you're giving a broader contribution…And that you are building up something more important, greater than your previous work…It requires you to be here on holidays, sometimes, and late at night. Which is something that you might have to do when you're a PhD, but it's ordinary life when you're a postdoc (Postdoc 7).

Research freedom in academic physics

However, the challenge does not prevent them from performing physics research. They are likely to take it as a part of enjoyment of research freedom that is a primary value for academic science careers (Fonseca, Velloso, Wofchuk, & de Meis, 1998) and physicists' desire and self-commitment to know or learn about universe and world nature (Hamer, 1925).

…also for trying to set up not well established technologies. Here, you get more funding to risk….More money to risk. To make that about new technologies that may be viable in the near future… (Postdoc 7).

I'm working on something and it doesn't matter, what kind of potential it is in. It's just doing something that is interesting. Yeah, that's basically it… I had quite a lot of [research] freedom,…(Postdoc 1).

Given that passing through PhD study indicates undertaking an enculturation process in the discipline (Delamont & Atkinson, 2001), higher expectations on performance are reasonable. In this sense, research training in physics, from undergraduate and PhD studies to the mature career, forms, in some ways, a continuum.

CONCLUSION

Postdocs and ECRs in academic physics are a lifelong learner group via academic professional development who are self-motivated, with a commitment to maintaining skills and gaining new knowledge through research, throughout their whole career. Their research training is continuing on a learning continuum from their PhD studies to independent scientists with highly specialised research skills to create new knowledge in academic physics.

Two prominent features of the changes one sees along this continuum of learning are, firstly, a shift from knowledge acquisition to knowledge creation. This may be a fundamental difference from other highly knowledge-based careers such as medical doctors and engineers in the continuing professional development of professionals in the workplace or in-service programs to learn and use the knowledge in order to provide public services (Storer, 1966). In particular, the act of knowledge creation—a key element of research in physics—is active, and independence and creativity are important. This is a major difference from the typically more passive undergraduate learning experience. It is useful for postdocs and ECRs (and perhaps even PhD students), and those who supervise them, to be aware of this transition.

Secondly, there is a broad range of skills required for successful work in academic physics beyond the scientific knowledge and technical skills that are the focus of undergraduate and postgraduate learning and training. Such skills include both specific tasks such as the preparation of research grant proposals and the preparation of publications, and more general skills such as the management of research groups, working in a team environment, supervision, and teaching.

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