

The Many Ways of Doing a PhD

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SUMMARY

Why is there variation in the degree of independence that mentees have in terms of their research? What are the consequences of this variation for both the mentors and the mentees? Should institutes take this variation into account while hiring or promoting faculty?

FULL ARTICLE

The PhD (Doctor of Philosophy) is more or less the highest degree that can be obtained in higher education. A PhD is awarded to a person who has shown evidence of conducting original research and has produced significant new knowledge in a chosen area of work. Most people work towards obtaining a PhD either because it has become an essential requirement for employment in research, teaching and other science and technology institutions or because it is fashionable and coveted even outside academia and research institutions, such as in business and industry, for example. Research towards a PhD is always carried out under the supervision of a senior authority in the field who is variously called the guide, supervisor or mentor. And the person working towards a PhD degree is variously called student, research scholar or mentee. I will deliberately use these labels interchangeably.

DIFFERENT MODES OF GETTING A PHD

Given that a PhD can be obtained in almost any branch of knowledge and the very different motivations for obtaining this exalted degree, it is not surprising that there is great variation in how a PhD is obtained. Although variation occurs in many dimensions and is continuous, I think it is useful to recognise three dominant modes of obtaining a PhD. For convenience, I will call these (1) Independent, (2) Collaborative and (3) Apprenticeship. The variation captured in this classification significantly impacts the relationship between the students and guide or mentor and the mentee. But, as I will show, these different modes of obtaining a PhD have important ramifications well beyond the mentor-mentee relationship. Because there is so much variation around these modes, my description below probably pertains to the extreme manifestations of these modes—the tips of the peaks surrounded by broad and deep valleys.

In the independent mode, the PhD student chooses a research problem, conceptualises and plans it, conducts the research and writes up her results almost entirely by herself. The mentor, as it seems most appropriate to call her in this mode of PhD, is a friend, philosopher and guide, in the best sense of this phrase. The role of the mentor is to offer advice, critique the work of the research scholar, suggest alternate ways of executing the work or interpreting the results, draw attention to the older literature and to other colleagues and scholars with whom the mentor may be more familiar because of her age and experience.

When the mentor similarly mentors two or more research scholars pursuing their PhDs in this independent mode, the group also provides an intellectual atmosphere and camaraderie with scholars interested in similar scholarly pursuits. Such camaraderie becomes mutually beneficial to all the research scholars. Usually, the mentor and her mentees are embedded in a larger department or institution, and these provide additional help and support. The research scholar may benefit from various academic resources that are part of the mentor's establishment and the institution but the mentor seldom explicitly supports the research scholar's

work financially. While research scholars may be generous in their acknowledgement of the mentor's advice and help, they seldom co-publish the outcome of the research. The mentor is usually pursuing her own independent research, perhaps not unlike the research scholar's, although it may be more advanced, more complex, and more long-term.

In the collaborative mode, as the name implies, a research scholar and her mentor share everything—choosing the problem, conceptualising and planning it, executing and writing it—more or less equally. Even in this mode, the research scholar may contribute more than her mentor in some components of the research, especially in the execution of the research plan. In an ideal situation, the research scholar and her mentor complement each other, bringing different matching skills to bear on the research. One of them may be more theoretical, and the other more empirical, one of them more mathematical and the other more experimental, one of them may have a more biological background, and the other may come from a more chemical, physical or engineering background and so on.

The original idea for the research may come from either the research scholar or the mentor. The mentor may already have the rough outline of a problem and may have been looking for a research scholar who can conduct the appropriate field or laboratory work or computer simulations and complement what the mentor cannot do, finds hard to do or does not want to spend the time to do. Conversely, a research scholar may wish to continue working on a problem that she has already begun in her undergraduate or Master's program and may be looking for a mentor who will help her take her research to the next level, which she is not able to do on her own.

There may be some inequality in contribution resources, with the mentor providing more funding and facilities. But in many cases, mentor and mentee apply for grants jointly, and the institution may provide many facilities and resources. Mentees may also have their own independently obtained fellowships, which include substantial research expenses.

In the collaborative mode also the mentor may be mentoring and collaborating with several research scholars working on related but quite different problems. The different mentees may also help each other or provide new ideas and perspectives on each other's research. In a friendly and intellectually honest environment, many publications may result from the participation of several individuals. In this mode, the resulting publications are almost always co-authored by the mentor and one or more research scholars. Usually, mutually acceptable ways are found to apportion the different research outcomes into several students' PhD theses.

In the apprenticeship mode, things are quite different. In the extreme case, the guide, as it is more appropriate to call her in this mode of PhD, has one or more long-term projects for which she has likely obtained large grants by promising specific outcomes. The long-term research projects, which can run for decades, are broken up into small chunks suitable for individual PhD student theses. The students have little or no flexibility in choosing the problem, the methodology to be used, or even the sequence of experiments. These are usually fairly well pre-determined and need to be executed as per plan. Because of the commitments made to the funding agencies, there is little scope for mid-course alteration in the plans, almost certainly not because of individual student preferences. Because of potential competition from other research groups and the interests of secrecy and priority, students often do not have the opportunity to discuss their work and be mentored by people outside the research group.

The broader significance of the individual student's research is often unclear even to the guide at the time. In many cases, the final goal is realised decades after the students have completed their work and gone on to pursue their separate careers. If successful, most of the credit goes to the guide with little possibility of any further rewards to the various students, other than their PhD's and some publications they have already got. The guide is often busy obtaining and managing grants, organising high profile publications, setting up new collaborations, serving on many committees and attending conferences.

The students do almost all the actual work as per the plans laid out. If the research groups are large, post-docs perform the task of the day to day mentoring of the PhD students. The students do get credit in the form

of their PhD degree and some publications. The publications often have many authors. The breaking up of the group's results into different publications cater to the larger interests of the group's research agenda. The timing and content of the publications are often influenced by what competing research groups do. The contributions of the individual students in the publications they co-author can become quite hard to discern. Indeed, the single authorship of the students in their PhD thesis is glaringly incongruent with the multiple authors in the published papers.

Many uncomfortable and unreasonable traditions have cropped up in an attempt to overcome this difficult situation. These include the implicit but never explicitly stated the significance of being the first author, the last author or the corresponding author. It is not uncommon to find such absurdities as co-corresponding authors! Even so, the originality and independence of the students are hard to discern. The cost of this is borne by the students, as it makes no difference to the guide. Many selection and hiring committees often wonder about the contribution of the applicant to their multi-author publications, which has led to the demand for proof of originality and independence in the form of further publications at the postdoctoral level.

It is a matter of satisfaction that some journals have begun to expect authors of co-authored papers to state each author's contributions explicitly. One could argue that this is not necessarily done honestly and that the power inequality between the student and the guide will once again work to the disadvantage of the student. Nevertheless, I think that this is a significant step forward. I hope more journals follow this practice. I suggest that journals should be evaluated based on such good practices rather than by their impact factors.

THE SOCIAL PRESTIGE OF THE DIFFERENT MODES OF PHD

I think that such variations in the ways of getting a PhD are perfectly natural. But, unfortunately, we attribute very different levels of social prestige to PhDs in different modes. We tend to hold the independent mode in very high esteem and consider the research scholars who obtain their PhD in this mode as the best exemplars of researchers. We value research scholars who obtain their PhD in the collaborative mode somewhat less because they need their mentors to carry out their research. But, it is the students who obtain their PhDs in the apprentice mode that we hold in the lowest esteem. We doubt their ability to think and work independently and tend to give much more credit to their guides, even without any evidence for doing so.

We like to believe, and make-believe, that a PhD degree is granted only for independent, original research and not for being trained as an apprentice, nor even for collaborative work. Only the name of the research scholar appears on the thesis. In many cases, it is required that the guide certifies that the research embodied in the thesis is the original, independent work of the scholar. And yet, the guides have no hesitation in being co-authors in the publications that result from the thesis and may be entirely justified in doing so. Isn't there something wrong in this double standard, in this discordance between practice and public posturing?

In my opinion, both the student and the guide need to come clean about their relative contributions and make the same claim in the thesis document and the ensuing publications. Such admission will require that we admit that there are multiple ways of working for a PhD and stop pretending that the PhD is a monolithic instrument. We need to understand why there is so much variation and realise that there is no simple relationship between the mode in which a PhD degree is obtained and the quality of the work, or indeed of the research scholars, nor even of the mentors. The different modes of PhD do not automatically map on to different, pre-determined academic qualities and standards.

THE CAUSES OF VARIATION

Why is there so much variation in how research leading to a PhD degree is carried out? It would be a mistake to think that the observed variation is caused merely by the corresponding variation in the students' intellectual abilities or the guides' attitudes. Important as these factors may be, much of the variation can be attributed to the nature of the research. Let us observe that the independent mode is most common in the humanities and some branches of the social sciences. It can also be seen in the natural sciences, albeit very rarely. In the natural sciences, the independent mode is more common in mathematics and the theoretical sciences. In biology, it is more common in ecology and evolutionary biology. This is because single individuals

can easily carry out research in these areas. Indeed, it often cannot be easily carried out efficiently by the participation of more than one individual.

The collaborative mode is somewhat more common than the independent mode in the natural sciences. In biology, there is once again a definite bias in favour of ecology and evolutionary biology as compared to cell and molecular biology, for example. Once again, this has to do with the nature of the research. The problems being tackled are amenable to collaboration between two or a small number of individuals and need relatively little expensive technology and facilities. The research problems come in relatively small, PhD-size packets and understanding the significance of current research does not have to wait for many more years of sustained work.

The apprenticeship mode, perhaps the most common mode in today's experimental natural sciences, is a very different ball game. The research problems being tackled often require or benefit from the collaboration of many individuals. They are much dependent on technology and funding. More importantly, they need many years, if not decades of sustained work by large numbers of people, to come to fruition. Such problems do exist, and many of them are extremely important. Many such problems are in the more applied sciences such as vaccine development, satellite development and deployment, but they may also be found in the more basic sciences, such as in the sequencing of genomes or research carried out at the Large Hadron Collider (LHC). Young people desirous of obtaining PhD degrees in these fields cannot participate in the research in the independent or small-scale collaborative mode. The apprenticeship mode is not only inevitable but also most appropriate.

Both students and guides may vary in their comfort levels in the different PhD modes, and intermediate PhD modes may develop in any kind of research. Nevertheless, it cannot be that the students' intellectual abilities or the intrinsic attitudes of the guides will vary systematically between these different kinds of research areas. The apprenticeship mode of a PhD can be simply an intelligent adaptation by the student and the guide to succeed in solving a certain class of problems. We must accept that the different modes of PhD can be a function of the different natures of the research and do not necessarily reflect different academic standards or intellectual qualities. It is not difficult to imagine that the quality of a PhD thesis carried out in the apprenticeship mode can be equal to or, indeed, far superior to some of those carried out in the collaborative or even in the independent mode. The same applies, of course, to the research scholars working in these different modes.

When the mode of doing a PhD is chosen inappropriately, without adequate regard to the needs of the research problem at hand, research carried out in any mode may suffer. If the research scholar, for example, does not have some of the crucial skills required or has inadequate background knowledge of the field, research carried out in the independent mode may be of relatively poor quality. In fact, there would be great danger that the mentor would not worry too much about this as it is not her research. Hence the research scholar who has inappropriately chosen the independent mode may suffer. A research problem requiring extensive collaboration and massive facilities may simply be poorly executed in a simple collaborative mode between one research scholar and one senior scientist. Such a duo may lose out to a large research group with much funding and many collaborations.

Despite the very high quality of the research, the PhD thesis of a research scholar in the apprenticeship mode may not meet the standards of originality and independence that we proclaim for a PhD. We should accept that the level of originality and independence of the research scholar will necessarily vary between different modes of doing a PhD. If we insist that all PhD research should have the same exalted level of independence and originality, we should award PhD degrees only to those scholars who work in the independent or collaborative mode, and all research carried out in the apprenticeship mode should not qualify for a PhD. This, of course, would be a great pity because the apprenticeship mode provides wonderful opportunities to train a large number of young people to become mentors in the future, even if they mentor students only in the apprenticeship mode. Instead, we must find ways of assessing the potential of people to work independently, even though they may not have done so before, just as we may need to find out if they can successfully work in the collaborative mode even though they may not have done so in the past.

Indeed, it may sometimes be in the best interests of a young person to gain expertise by working in the apprenticeship mode and use the skills so gained later in life to do independent and original research. Originality and independence should not be deemed to be so sacred as to sacrifice the quality and importance of scientific research and training. It is not so difficult to calibrate the value of independence and originality depending on the nature of the research problem. I once met a very frustrated young student who complained that she had an excellent idea for research but could not find a guide who was already working on that problem. I explained to her that she should consider this her great fortune, put her idea temporarily on the back burner, work with any guide under whose mentorship she can acquire all the required skills needed to solve her original problem and tackle it later as an independent researcher.

By not recognising the genuine and inevitable variation in the modes of doing a PhD and insisting on painting them all with a single brush, and holding them to the same exalted standards of originality and independence, we are doing great harm to research scholars working in some areas. Even more importantly, by not recognising that PhD done in different modes are quite different, we are blind to the inevitable consequences of these different modes of PhD research. And such blindness can have disastrous practical consequences, many of which I believe we are witnessing today.

THE CONSEQUENCES OF VARIATION

There are several important consequences of the diverse modes of doing research towards a PhD. One of them concerns the motivation of mentors to mentor PhD students. Such motivation is lowest in the independent mode, somewhat higher in the collaborative mode and very high in the apprenticeship mode. I have heard many humanities and social sciences professors complain that their institution forces them to take on too many PhD students. They have told me that although they recognise that mentoring is an essential service, PhD students take away too much of their time which they could instead use for their own research. It is quite rare that the student helps in the research of the mentor in any significant way. Thus mentoring is viewed as a service that they perform because they are required to do so.

Mentors are somewhat more motivated in the collaborative mode because their research also depends on collaboration with their students. Nevertheless, they would rather take a fairly small number of students as they have to be a nearly equal partner with each one of them. Conflict only arises when their institution requires them to train more PhD students than they would like to.

In the apprenticeship mode, the situation is entirely different. Mentors would like to take on as many PhD students as the system will permit. It is not uncommon for senior-high profile scientists to have ten or twenty PhD students. The number of PhD students they can take is only limited by funding and institutional limitations. If we wish to develop a policy for increasing or decreasing the number of PhDs we want to produce per year, then the mode in which the PhD is done is a critical factor that will decide whether the policy succeeds or not. Indeed, the independent and collaborative modes of PhD are not conducive to an institutional or national effort to significantly increase the number of PhDs.

A second important consequence concerns the freedom that the research scholar has. In the independent mode, the research scholar has total independence. Because it is she who chooses the research problem, conceptualises it, plans and executes it, she's free to change her plans at any time, perhaps even to abandon one line of research entirely and take another. Even if she decides to discontinue her PhD, this has relatively fewer negative consequences for others compared to the collaborative and apprenticeship modes. Therefore she is under less pressure to persist.

In the collaborative mode, there is somewhat less freedom than in the independent. Nevertheless, there is considerable freedom because the student has to negotiate with just one person – her mentor and the two of them may easily steer their collaborative research in a mutually beneficial manner.

It is in the apprenticeship mode that the student has the least freedom. The student should continue to do what she has been told to, and she has agreed to do; discontinuing would be seriously frowned upon as it may jeopardise or delay the larger research plan of the group, and it may negatively affect not only her guide

but many other students and collaborators participating in the network.

Naturally, the different levels of freedom impact the life and comfort of the research scholars in significant ways. In general terms, the more freedom, the less stress and frustration, at least for students who prefer to work in the independent mode. The research scholar, especially in the independent mode and to some extent in the collaborative mode, is really following her passion and doing what she really wants. There is a much greater chance that she is enjoying her research because if she didn't, she could always change. On the other hand, while some students may be very happy in the apprenticeship mode, it is easy to imagine that others may not be. The lack of freedom and the pressure to perform at a rate and at a level of efficiency that matches the rest of the research network can be very stressful. The difficulty of changing or abandoning the research midway can make life even more stressful. It is possible that students in this situation do not see themselves as pursuing their passion and enjoying their research but as being employees in a high-stress job. They may consider the end of the PhD a great relief, and many may like to take an extended break to recuperate.

If we wish to develop policies to maximise the happiness and well-being of research scholars, then the mode in which they are doing PhD will be an important factor in framing suitable policies. Indeed, the need for institutional intervention to prevent stress and frustration, unhappiness and disappointment, maybe much more required when an institution has many students working for their PhD in the apprenticeship mode.

Yet another consequence is in the area of apportioning credit. In the independent mode, the problem does not arise in the first place. There are relatively few opportunities for conflict in the collaborative mode and many ways of settling them quickly and amicably. It is in the apprenticeship mode that there are huge problems, often with no obvious solutions that do justice to all. A great deal of compromise and acceptance of good and bad luck may be required for reaching amicable settlements of any conflict.

In extensive research networks, it is often very difficult for anyone to know for sure who first had a brilliant idea, who first found something interesting or who was indispensable for the final result. Conflicts can occur not only between the guides and their students but even more seriously among the students themselves. I have already alluded to the problem of co-authorship. I know of many cases where authorship, rather than merely being a function of actual contribution, becomes an instrument of negotiation for past, present and future favours, even if the favours are strictly academic and in the cause of the research. As I have already pointed out, the students bear the brunt of the negative consequences of such conflicts. Once again, if we wish to design institutional policies for maintaining ethical norms and best practices in the research environment, it will become essential to consider the modes in which students and guides work with each other. Ideally, both students and guides should be flexible in shifting between the three modes as and when required. But if they cannot be flexible, then students should be very careful in choosing their guides, and guides should make their preference known beforehand.

Another obvious consequence is in the area of responsibility. Just as it may be challenging to apportion credit, it would probably be even more difficult to apportion blame when something goes wrong. Who is to be held accountable for errors in the data arising out of carelessness or deliberate fraud? Who is to be held accountable for data manipulation and plagiarism when there may be dozens or hundreds of authors on a paper? While these problems are almost non-existent in the independent and collaborative modes, they can assume severe proportions in the apprenticeship mode. It seems meaningless to make policy decisions in the organisation of a research environment without recognising the vastly different modes of obtaining a PhD.

Perhaps the most severe consequence is in the matter of the mentor-mentee relationships. The inevitable power imbalance between a young student and a senior mentor hardly matters in the independent mode. They may matter somewhat in the collaborative mode but are relatively easily settled, if necessary, with an easy divorce. But these problems can take on an altogether different and massive dimension in the internship mode. It is being increasingly realised that institutions need to put in place many policies and practices to create a healthy, friendly, honest, trustful and inspiring atmosphere where research is carried out. The lion's share of research, at least in India, is carried out by PhD students. And yet, surprisingly little attention is paid to the diversity in the modes of obtaining a PhD.

In conclusion, I wish to reiterate that we must recognise the existence of significant variation in the modes of PhD research, accept the different modes for what they are, reap the benefits of their advantages and minimise the difficulties they may create. Institutions of research and higher education have a great responsibility in this regard, one of which is to find appropriate ways of evaluating mentors who work with PhD students in different modes. As for the individuals, both mentors and mentees, must recognise the diverse modes of PhD and choose wisely and be honest about it.

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