

A Supportive Approach to Supervising Students Reading for a PhD in Systems and Software Engineering

Richard Lai

Department of Computer Science and Computer Engineering, La Trobe University, Melbourne, Australia
Email: lai@cs.latrobe.edu.au

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Supervising a PhD student is a complex teaching task as it involves a very unstructured environment and many intellectual challenges and stimuli, and it often requires a compatible student/supervisor relationship for successful outcomes. It is therefore not surprising that it has been reported that an aspect of teaching and learning that has been overlooked in higher education is research student supervision. Typical problems of poor supervision include: high rates of dissatisfaction with supervisors and high attrition rates and slow rates of completion for students. It has also been reported that there is no set prescription on appropriate and successful supervision; rather, the interactions between quality and style of supervision, and the field of study have all to be considered. It is not easy to know what a student and his/her supervisor should be doing in order to succeed. We are thus motivated to present in this paper our approach to supervising students reading for a PhD in systems and software engineering. This approach is centered on motivating students to learn and to do research by having supervisory activities that support their development throughout their candidature.

Keywords: PhD; Supervision; Systems and Software Engineering; Motivation

Introduction

A definition of a PhD (LTU, 2006) is “PhD degrees provide training and education with the objective of producing graduates with the capacity to conduct research independently at a high level of originality and quality.” Supervising a PhD student is a complex teaching task as it involves a very unstructured environment and many intellectual challenges and stimuli, and it often requires a compatible student/supervisor relationship for successful outcomes. It is therefore not surprising that Armstrong (Armstrong, 2004) reported that an aspect of teaching and learning that has been overlooked in higher education is research student supervision. However, the Australian government viewed PhD student supervision as important; and as such, the Department of Education, Science and Training Australia, required universities to describe their support of PhD students and the supervision outcomes in the 2008 Research Qualify Framework (RQF) submissions (DEST, 2007).

There is very little cross-institutional agreement on what constitutes a good PhD thesis and what would make sound supervision practice (Sinclair, 2004); hence it is not easy to know what a student and his/her supervisor should be doing in order to succeed. We often do not have model answers to questions like “How do we inspire, motivate and support a PhD student?”, “What topic should he/she conduct research in?”, “How do we measure the quality of a PhD thesis?”, and “How do we lead him/her to progress well in his/her research?”. On the contrary, we do know the problems that are associated with poor PhD supervisions. Typical problems of poor supervisions include: high rates of dissatisfaction with supervisors (Cullen, 1989) and high attrition rates and slow rates of completion for students (AVCC, 1990). The need for supervisors to provide sound supervision practices is therefore paramount.

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propriate and successful supervision; rather, the interactions between quality and style of supervision, and the field of study have all to be considered. Our field of study is Systems and Software Engineering (SSE) (Glass, 2000). Today, sophisticated and complex engineering systems are controlled and monitored by sophisticated computer systems which are required to deliver secured, quality and reliable services. SSE is an engineering discipline concerned with the processes, techniques, principles and theories for constructing a sophisticated software system for a complex engineering system. It involves the application of a systematic, disciplined, quantifiable approach to the design, development, operation, and maintenance of complex systems like aircraft, high speed train, power plant, and telecommunication. SSE is also heavily used within the US Department of Defence as it is required to deliver to its arm forces incredibly effective and powerful weapon systems utilising complex software systems. The term software engineering (Sommerville, 2010) first appeared in the 1968 NATO Software Engineering Conference, and was meant to provoke thought regarding the perceived “software crisis” at the time.

Given these facts about PhD supervision, we are thus motivated to present in this paper our approach to supervising students reading for a PhD in SSE. This approach is centered on motivating students to learn and to do research by having supervisory activities that support their development throughout their candidature. Our approach has been in use for about than 20 years.

Overview of the Approach

Our PhD supervision approach is influenced by two old sayings: namely, “The blind leads the blind” and “There are no lazy people in this world, only unmotivated ones”. We therefore see

that PhD supervision is about leading, inspiring, motivating and supporting students to learn and to develop their research potentials by making good uses of our mastery knowledge, time, and resources.

From our own experience, doing a PhD requires an enormous amount of motivation which is confirmed by Karimi et al. (2007). Motivation is at the very heart of personal effectiveness. When one is motivated, one has great enthusiasm and energy to do the work and to get it done. There are two types of student motivation: extrinsic and intrinsic (Ryan et al., 2000). We aim to have quality interactions and activities with our students, resulting in extrinsic and/or intrinsic motivation in them (Dev, 1997).

We lead, inspire and motivate students by having mastery knowledge in the research area and helping them to do likewise. We motivate them to progress well throughout their candidatures by giving them the right topics, the supports, the interactions, the guidance, the cares, and the goals they need.

An Active Supervisor

The old saying—"The blind leads the blind"—teaches us that we would not be able to lead our PhD students well if we do not have a good knowledge of the subject matter ourselves. The starting point for us as a supervisor is therefore that ideally we should have a mastery knowledge in the research area in order to be able to inspire and influence them. The better we are as a researcher, the higher chance that we become a better supervisor. In addition to keeping up with our research, we maintain our mastery knowledge by being scholarly and professionally active. We serve on the editorial boards of international journals and as guest editors of special issues of international journals. These work enhance our skills in judging the qualities of research papers; as a result, we are able to guide our students better to do researches that are worthy of publication in internationally reputed journals.

We give speeches and participate in panel discussions at international conferences, and serve on the program committees of international conferences. These heighten our awareness of some of the latest researches that are conducted in other parts of the world, and enable us and our students to get connected with our international peers and to receive feedbacks for our work.

We stay in touch with the SSE industry by attending conferences which are mainly for SSE practitioners so that we can keep up-to-date with their current practices and the real-life problems that they encounter. As such, we are able to enhance our skills in teaching and in influencing our PhD students about how to make their researches more industrially relevant. Apart from supervision, we are also interested in teaching in general (Lai, 1992; Lai, 1994a; Lai, 1994b; Sharma et al., 1995).

Teaching Them the Basics of Doing a PhD

We always ask our students the question: "Why do you want to pursue a PhD?". We get them to understand that doing a PhD is to undergo a training in learning how to do research and that obtaining a PhD is necessary for having a research or university career. However, we point out to them that pursuing a PhD in order to get a doctoral title and to make lots of money is an inappropriate motive. High motivation is bound up with having a clear sense of direction and a goal. We explain to students that a PhD project can be one of the most fascinating and exciting learning experiences. However, it can also be challenging, demanding much hard work and a sustained personal commitment

during three or more years. By going through a copy of a former student's PhD thesis with them, they understand what constitutes a PhD thesis and how it can be brought to a completion. They then develop a positive and proper attitude towards earning a PhD.

We share with students about the facts that a research career can bring rewards unequalled in other professions, that they could extend their intellectual capabilities, that they could meet some of the brightest people on earth, that they could solve problems not solved before, that they could discover things no one has discovered before, and that they could uncover methods that could change the way people develop computer systems. The joy of doing research will keep them motivated for a long time.

Motivation is about enthusiasm and harnessing one's energies, and therefore in a practical sense it relies on a life style which promotes vitality, rather than fatigue. We encourage students to maintain an effective balance between their work and personal activities, to have regular exercise and to connect with friends and family so that they will not feel isolated and become depressed. Succeeding in a PhD requires an enormous amount of self-discipline. Unlike a coursework, there is no structure in a PhD study. Research students who lack sufficient discipline will not be able to establish a good work routine, and will soon find themselves sleeping until late in the morning. We teach them to have the daily discipline by emphasising the fact that they should treat the PhD study like having a paid day job, enabling them to work productively.

Imparting Research Skills to Them

We teach students the following essential and fundamental research skills and abilities: effective technical paper reading, how to identify the key aspects of a problem/area, critical thinking, evaluation and analysis of related work, acquiring expertise in a specific area, working independently, and problem solving.

We show them how to grasp the contributions of a research paper, how to identify the strengths and weaknesses of the research technique described, how to summarise the finding after reviewing technical papers available in the literature, etc. Students will then acquire a broad knowledge in the research area.

Smaller successes lead to bigger accomplishments. We teach them the principle of "Success builds on a success". If they could achieve smaller tasks, they will naturally be on the right track. In the event that they could not achieve a smaller task, we would discuss with them about the problems they encounter and through discussions we always could come up with a solution (or a partial solution) to the problem; in this situation, only a minimal amount of time is lost.

We explain to them that SSE researches can include such diverse activities as designing and building new computer systems, writing computer software, measuring the performance of a computer system, or using analytical tools to assess a design. Research activities vary from project to project and over time in a single project.

Guiding Them to Work on the Right Topic

All of our former students asked us the question: "What topic should I be doing for my PhD?". We get a student to work on a topic that is of mutual interest so that we become highly motivated about our project and develop a deep rapport for it. Students will then be committed to the area of research; and the

research topic provides them with a great source of motivation and inspiration. A strong belief in the research area is essential to enable a student to get through a PhD.

Students are motivated from within themselves. They want to learn a subject or topic taught for different reasons. Once a specific topic arouses their interest, they will be motivated. Students should be interested in the research area in which they have a mastery knowledge. Supervision of PhD student should be regarded as a shared enterprise in which both a supervisor and his/her student have an intellectual investment. Proposed research projects should therefore be of mutual interests.

At the beginning, students usually do not have the expertise to know what topic is feasible for a PhD project. If they were to work out the topic by themselves, it could easily take them 6 to 9 months to do it. Not all research topics that we have in mind are suitable as research projects for students. We have to guide them to work on the right topic, based on their strengths, weaknesses and interests. For instance, there is no point in guiding them to do a highly mathematical oriented research if they were not good in mathematics. After deciding the right topics, we also make the topics very specific for them to work on. Our former PhD students worked in the area of systems and software engineering which we both had mutual interests, and they were able to grasp the research issues quickly. They are then inspired because they have a good start.

Helping them Build a Mastery Knowledge in the Research Area

We also show them how to be an effective reader so that they can get a lot out of reading an article within the shortest possible amount of time, and how to choose what needs to be read. We teach them how to manage their time well. These basics are very essentials. Without them, it would be hard for them to finish on time. We guide them to do a rather comprehensive survey of the research work done in the area of interest, so that a broad knowledge of the research area is built into them during the process.

An old saying is "You give him a fish today, he feeds himself one day; you teach him how to fish, he feeds himself all the days of his life." Our PhD students cannot rely forever on our mastery knowledge; we have to help them develop their own. When exploring a new concept, we get them to notice how it is the same as something they already know. Students are more likely to remember new information if they can connect it with familiar previous knowledge or experience. While they explore how similar two objects are, they are also taught to explore their differences. Students gain as much understanding of a new concept by identifying what it isn't as by identifying what it is. At this stage in the process, we get them to practice the new concept to gain conscious mastery. They have reached concept mastery when they are able to combine a new concept with previous knowledge or experience, and apply the new concept in new and creative ways.

Giving Them Prompt, Regular and Constructive Feedbacks

Apart from meeting with them very regularly, we make sure that we respond to their needs and give feedback to them on their work promptly because students need to know how they are doing so that they can improve if the performance is below standards and their confidences would be further built up by receiving positive feedback from us when they have done a good

job. A prompt feedback is very important as students could have gone off track in their work and a mid course correction is required. If we did not give them prompt feedback, much more time and energy would have been lost, thus prolonging a student's candidature.

We encourage students to put in writing the ideas, the discussions that we have, the literature search results, research findings, and difficulties and problems from the start. Soon, what they have written down will fall in places and form parts of their thesis. It is through something in writing that we are able to give them concrete feedback on their trends of thought, the quality of the work, future direction, and how to refine and expand their work. This approach is consistent with research studies which have shown that those who are required to submit written work earlier in the candidature were the most satisfied with the feedback that they received (Davis, 1993).

Imparting to Them the Skills in Presenting Research Results

After a student agrees to go ahead in a certain research direction, we are eager to seek the reactions of a wider audience by sending a paper on the PhD work to a conference programme committee for consideration for presentation as we admit that we do not know everything. This opens us to public scrutiny. We help our students develop a positive attitude towards criticisms or negative comments. The truth is that if one decides to embark on something new in his/her life, then he/she has to accept criticisms made by our peers on the inadequacy of the work, and he/she will learn and grow in competence. Thus, criticisms become not an indicator of personal inadequacy, but a sign that he/she is expanding his/her horizons and making progress. Receiving criticisms on the inadequacy of the work is a form of feedback and a necessary part of the learning process so that we can move on to achieve bigger goals.

When presenting a paper, they have an opportunity to interact with researchers from around the world and to get feedback from them. Studies have shown that there is a significant relationship between the level of research student satisfaction and feedback and advice received from oral presentations (Heath, 2002). We teach students how to develop the contents of a presentation; they include: a statement about its aim, the motivation of doing the work, some brief discussions on how the work is compared with those of other researchers, the research results, the strengths and weaknesses of the technique used, and a conclusion that summarizes the contribution of the work. We discuss with them some of the good presentation skills which include focusing on the audience instead of looking at the slides, speaking naturally instead of reading word by word from the notes or slides, speaking clearly and slower, and preparing well for the presentation. We teach them how to answer queries and objections raised by the audience; the key to handling them well lies largely within their knowledge and confidence in the work that they have done, and it is not a human weakness to acknowledge the shortcomings of the technique/approach they have developed.

Imparting to Them the Skills in Publishing Quality Papers in SSE Journal

After more solid research results have been obtained, we en-

courage and teach them to write a paper for submission to the editorial board of a SSE journal for consideration for publication so that more serious feedback can be obtained from experts in the research area. The interactions and feedback help them stay motivated and stimulated.

We explain to students the review process of a journal paper, the persons responsible for the review, and the time taken for reviewing a paper which is usually at least about six months (or possibly twelve months). We show them how to make a right judgement in sending a paper to the right journal by studying the scope of the journal and the style and the standard of papers that have been previously published in that journal, as the cost of having a paper rejected is too high. We teach them the important ingredients of a quality journal paper. For examples, the abstract, the introduction and the conclusion parts must be well written, concise and clear about the contribution and significance of the research conducted; these parts should also explain why the work is better than similar work done by others; the technique employed in conducting the research normally has to be novel or innovative; and the arguments developed are to be convincing. We teach them how to revise a paper by responding appropriately to reviewers' comments, especially the negative ones.

Conclusion

We have used this approach to supervising SSE PhD students over the last 20 years, during which nine PhD students had been supervised to completion. Notably, all of them were born and educated in an overseas country before coming to Australia to pursue a higher degree. They had the special need of being able to complete their PhD as quickly as possible. Incidentally, the Australian Government's grants to universities for local PhD students are limited to a candidature of four years only (Sathye, 2005).

With our approach, we were able to lead, inspire, motivate and support them to achieve quality research results within the desired period of candidature of between three to four year, during which they were also able to publish quality journal and conference papers on their thesis. To support this claim, we mention below the outcomes of a couple of our former PhD students. In November 2007, Student A (just a name in order to preserve his identity) submitted his thesis for examination after having published three journal and one conference papers on his thesis during a candidature of 3.5 years. In February 2008, without having received his PhD results yet, he was awarded an Early-Career Researcher grant by a learned society in Australia for conducting research in an overseas country for two months; and in 2009, he was awarded a research thesis merit citation by the Faculty of Science, Technology and Engineering of La Trobe University. In July 2010, Student B submitted his thesis for examination after having published two journal and one conference papers on his thesis during a candidature of merely 3 years. In January 2012, he was awarded an outstanding young researcher award by the Vice-Chancellor of the University where he has been working since completing his PhD.

We thus conclude that the approach to supervising SSE PhD students we having been using is about supporting them by being: 1) their teacher who imparts knowledge to and provides training for them; 2) and their coach who builds skills and confidence in them. The outcomes of the supervisions of our former nine SSE PhD students support the fact that it is an effective method of supervision.

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