Effective supervision: A case study in engineering research

Xu Huang

School of Information Sciences and Engineering, University of Canberra, ACT 2601, Australia
Xu.Huang@canberra.edu.au

Dharmendra Sharma

School of Information Sciences and Engineering, University of Canberra, ACT 2601, Australia
Dharmendra.Sharma@canberra.edu.au

Abstract: It is a fundamental concern to both the supervisor and student is effective supervision throughout the entire period of candidature in engineering postgraduate research supervision. A case study in an software engineering postgraduate (by research) supervision is presented in this paper, by which it is claimed that effective supervision is built on a constructive and supportive relationship between supervisor and student in the engineering postgraduate supervision. The contribution of this paper is to provide supervisors of engineering postgraduate research students with some suggestions that can enhance the interactions with their postgraduate students and build real effective supervision.

Introduction

As McCormack [McCormack, 1998] described that "being a postgraduate supervisor is intellectually and emotionally interesting work. It opens up new opportunities to: work with academically able students; collaborate in the area of research and publication; share ideas; and learn about new areas or different of approaches to research. Brown and Atkins described the supervision of postgraduate students as "the most complex and subtle form of teaching in which we engage" [Brown and Atkins, 1988]. Parsloe said "the most satisfying part of my very privileged job as a social work teacher" [Parsloe, 1993]. In fact, supervision is a distinctive teaching and learning process used for graduate research education.

However, significant developments in postgraduate research education in Australia occurred in the 1990s, many of them as a result of Government policy. A valuable source of data about developments in this area of Australian higher education is the five "Quality in Postgraduate Research" (QPR) conferences held biennially in Adelaide, Australia and sponsored by the three South Australian universities. "The QPR conferences are now well established as a meeting place for supervisors, postgraduate students, support staff, policy makers, administrators, members of government agencies and those who research in the area of postgraduate education. These conferences have provided an opportunity to debate current policies affecting postgraduate education; to exchange views on current research and good practice; and to link staff and student interest groups" [Kiley, 2003].

There are thirteen principles for successful higher degrees by research supervision proposed by Parry and Hayden as shown in Table 1 [Parry and Hayden, 1994]. These thirteen points were discussed as if the responsibility lay only with individual supervisors, and not with Departments or Faculties [Mullins and Kiley, 1998].

Clark described postgraduate skills (Clark, 1996) that virtually every university in Australia now has a list of "generic/transferable skills" for postgraduate students as shown in Table 2.

For example, student at the University of Canberra, with her/his supervisor develops a personal learning plan for candidature. The learning plan is reviewed at least annually, takes into account the University's agree learning outcomes for Higher Degree Research (HDR) graduates, the student's experiences, the discipline, the research topic and the skills and experiences of supervisors.

Table 1: Thirteen discrete phases in supervision (Parry and Hayden, 1994)

1. Recruiting and selecting students	2. Allocating supervisors
3. Providing guidelines	4. Selecting the topic
5. Giving advice about how to do research	6. Meeting with student
7. Helping students to write	8. Maintaining a working relationship
9. Checking process	10. Introducing students to scholarly networks
11. Ensuring acceptability of the thesis	12. Selecting examiners
13. Providing career support	

In this paper we are focusing on a case study in the area of signal processing in software engineering postgraduate (by research) supervision, by which we show that effective supervision is built on a constructive and supportive relationship between supervisor and student in the engineering postgraduate supervision. For example, as a supervision panel, how do you provide guidelines and selecting the topic (which are the numbers 3 and 4 in Table 1)? We have concerned the students' qualities and skills listed in Table 2, in particular number 1, 2, 7, and 9.

Table 2: Postgraduate qualities and skills (Clark, 1996)

1. Highly developed skills to adapt to new areas of activity	2. A reasonably broad practical knowledge
3. Familiarity and knowledge of broader literature	4. Skills in the scientific method and linkage to the broad context
5. Good communication and presentation skills	6. Good work practices and collaborative skills
7. Experimental design, modelling and statistics	8. Information technology and computer literacy
9. The ability to use fundamental and technical knowledge to applied systems	10. Occupational health and safety, and hazard analysis
11. Good manufacturing practice	12. Good laboratory practice
13. Intellectual property management skills	

The case study is embedded in engineering education where there are constant pressures to incorporate the engineering postgraduate qualities and skills that reflect rapid technological advances, which fosters our engineering students not only "know what" and "knowing how" but also can apply the skills to the research project to achieve expected results and completed his/her higher research degree. Clearly, there is a significant momentum to update top-end technologies our engineering postgraduate candidates need to follow by which to create new innovations, which our supervision panels aggressively pursue.

The Case

The student, John, came to see us for his potential postgraduate study (by research) with the situation listed in Table 3.

Table 3: Information about the Engineering Postgraduate Candidate

Student Name	John (due to privacy we did not put real name)
Student age	mature age
Student Background	He has been working at the government depart for about 6 years after he obtained his first degree in computer engineering. He would like to seek higher degree along his first degree direction by research with the motivation of catching updated cutting edge technologies in this field and improving his current working environment.
Study style	He is going to take part time study at the University of Canberra due to his working still needs him.
Enrolling Time	As early as possible

Nature of postgraduate research student and supervisor

The first issue of importance is the nature of postgraduate research student and supervisor. As research supervisors, we have to be skilled in enabling our research students to acquire those techniques and methods themselves without stultifying or warping their own intellectual development. In short, as Brown and Atkins said one "to be an effective research supervisor, one needs to an effective researcher and an effective supervisor" [Brown and Atkins, 1988]. It is obvious that the effective supervision is built on a constructive and supportive relationship between supervisor and student in the engineering postgraduate supervision. Therefore we need to close look at the roles of the supervisor as described by Brown and Atkins [Brown and Atkins, 1988] as below:

Table 4: The role of the supervisor

1.	Director (determining topic and method, providing ideas).
2.	Facilitator (providing access to resources or expertise, arranging field-work)
3.	Adviser (helping to resolve technical problems, suggesting alternatives)
4.	Teacher (of research techniques)
5.	Guide (suggesting timetable for writing up, giving feedback on progress, identifying critical path for data collection)
6.	Critic (of design of enquiry, of draft chapters, of interpretations of data)
7.	Freedom giver (authorizes student to make decisions, supports student's decisions)
8.	Supporter (gives encouragement, shows interest, discusses student's ideas)
9.	Friend (extends interest and concern to non-academic aspects of student's life)
10.	Manager (checks progress regularly, monitors study, gives systematic feedback, plans work).
11.	Examiner (e.g. internal examiner, mock vivas, interim progress reports, supervisory board member).

In fact, what seems likely is that within a general orientation supervisions move from one role to another. The relationship between research postgraduate student and the supervisor changes from time to time and from case to case. These changes, conscious or unconscious, may be triggered by the personality of the individual research student or by the nature of the project. More commonly, the changes occur as different stages in the research project.

It is our experience that before making a decision about offering a position to a research postgraduate student an interview is extremely important even a telephone interview

(especially for overseas students), by which you can obtain information to verify the written material.

In our current case, John needs to have a clear understanding of research topic that can lead him to realise his potential capabilities and expected targets, since he would know what he wants but would not know how to approach it.   Therefore, the listed number 3 and 4 in Table 1 are the role for the supervision panel and the number 1 and 2 listed in table 4 become very important for this particular case.

Knowledge of expectations

To establish and maintain a constructive and supportive supervisory relationship both the research students and supervisors need to understand what the expected things are from other part at different stage.

In the beginning, when the student working out the topic of the research project under the help of the supervisor (or supervision panel) the supervisor will expect the research student will follow the discussed research direction to do more work to support the designed research framework and the research student will expect the supervisor to give more supports for the coming difficulties from the research project, including, methods, skills to deal with problems, coherent relations among different core questions, etc.. Those expectations are not always matching. For example, when research project goes deeper, the postgraduate research students drawing on undergraduate experience had expected the supervisor to provide detailed comments on all aspects of the material submitted, as well as an overall evaluation of it. The supervisor in this case saw the student role in examining the student's written material as one of commenting on particular aspects of the student's work and using these comments to form the basis for discussion. Rather than viewing the submitted work as a final document in which every word needed comment, the supervisor saw the work and gave comments with the aim of furthering the student's understanding.

Powles in his paper suggested what supervisors should do [Powles, 1994] as listed in Table 5.

Table 5: Powles listed the issues supervisors should consider.

• Supervisors are expected to provide continuing guidance to candidates on research being undertaken and on meeting time-lines
• Supervision should be regarded as a shared experience
• Proposed research projects should be of mutual interest
• Supervisors should have a sufficient range of theoretical methodological expertise to offer the student proper supervision
• There should be adequate time to supervise when other commitments are taken into account
• Be well acquainted with the candidate's academic background and inform the candidate if the proposed program needs additional skills
• Alert the commencing student to commonly encountered tasks, processes and standards
• Assist the student to formulate a framework for research and time estimates for completion of various phases
• Confer with the student at agreed intervals
• Read any written work thoroughly and in advance of meetings and provide regular feedback on student's work
• Ensure candidates are included in the life of the department
• Initiate discussions about intellectual property
• Not lose sight of the personal dimension of the supervisory relationship
• If the supervisory relationship breaks down see that other arrangements are made to the satisfaction of the student

- Actively support the university's policies and strategies on affirmative action and avoidance of sexual harassment

Postgraduate students felt the responsibilities of a student should do as shown in table 6.

Table 6: Postgraduate students responsibilities (University of Canberra, 1993)

• Maintain regular contact with the supervisor
• Listen and debate issues
• Prepare for consultations
• Take imitative
• Seek/follow advice
• Stick to deadlines
• Negotiate needs and expectations with supervisor
• Develop autonomy/self-direction
• Foster relationships with supervisor

One of the keys to establish and maintain a constructive and supportive supervisory relationship between both the postgraduate research students and supervisors is implementing the "milestones and requirements" as shown in Table 7 (University of Canberra, 2006) based on mutually understanding the above knowledge of expectations. For our case, John and the supervision panel smoothly carried on the requirements and established every required milestone in the whole research process. We have run weekly meetings, which is extremely productive and ensured the "learning plan" had been followed. During his research postgraduate study for his Master degree, we have published four papers in Journal and IEEE International Conferences.

Communication Channel

The establishment and maintenance of a constructive and supportive supervisory relationship heavily relies on good and effective communication channel between research postgraduate student and the supervisor. The first thing needs to be done is to know yourself and your research student via the established an effective communication channel.

At the University of Canberra a staff member becomes a supervisor for a research postgraduate student needs to meet the requirements of a registration form, including basic course training, and research capability checking, etc. Before accepting to be a supervisor of a postgraduate student a supervisor needs to take stock of the person's own situation (and also the situations about the member of the supervision of panel), including the credential and workload experience in this particular project, personal issues, etc.

Isolation is a problem commonly experienced by postgraduate research students which can be reduced by an alert supervisor directing the affected student to student networks within the faculty or to campus-wide organisations. In particular experience shows for the engineering research postgraduate students may work with no other person. Therefore, it is necessary that fostering a feeling of collegiality within the school so students feel part of a community of scholars also provides supervisors with the opportunity to seek support from colleagues and to exchange ideas. If the research postgraduate student is from overseas, the situation may be more serious and the supervisor needs to pay special attention.

An affective communication channel is extremely important by which it can be done that genuine concern for the student, regularly expressed and made part of the relationship from the first meeting, contributes to a comfortable and relaxed atmosphere in which to foster a workable relationship. Research literature indicates that good communication is fundamental to supervision. It plays an important role in building trust and goodwill, and helps prevent misunderstandings between supervisor and student.

At the University of Canberra, "Requirements and milestones: what am I expected to do?" [University of Canberra, 2006] shows some important requirements need to be completed for the research postgraduate student supervision as shown in Table 7. In fact by our experience, the completion of the "requirements and milestone" is totally underpinned by the communication channel. In our case, John completed his "initial seminar" he thought it would be enough for his carrying on his thesis when we advise him that the "security in XML" and "statics system to dynamic system" should go into his future thesis about his XML system.

Table 7: "Requirements and milestones" [University of Canberra, 2006]

Requirement	Timing	Who do I work with and who validates?
Enrolment	Before the start of each semester	• Student Services
Learning plan	Within 3 months of commencement of research phase. Reviewed by candidate and supervisor at least annually	• Supervisor • Supervisor advises Research Degrees Committee) for noting • Reported on in APR (Annual Progress Report)
Final research proposal	As soon as possible and certainly before the initial seminar where it will be handed in for assessment	• Supervisor • Initial seminar assessors confirm, DRDC is advised
Ethics approval	As soon as you know what you are doing – definitely before starting the research	• Ethics committees
Initial seminar	Within 6 months for full time students	• Seminar assessors • Supervisory panel • DRDC notes whether satisfactory or not and advises candidate of approval to proceed • Noted in first APR
Annual Progress Report	Each year (around September to October)	• Supervisor • DRDC
Second work-in-progress seminar (PhD only)	In second year (for full time students)	• Supervisory panel • Noted in next APR
Conference attendance/presentation	Anytime during candidature	• Incorporate in learning plan • Not mandatory, but highly recommended
Publication	Anytime during candidature	• Incorporate in learning plan • Not mandatory, but highly recommended
Final seminar	When the thesis is finished or about to be finished	• Supervisory panel and wider community • Supervisor advises DRDC that seminar has

			taken place
Submission of thesis for examination	Within 4 years for PD and PhD students-2 years for Masters students		• Supervisory panel • DRDC • URDC
Submission of final copies of thesis	After examination and when required changes (if any) have been made		• Divisional research degrees officer/ORRD • LIBRARY

Discussion and analysis

It is a fundamental concern to both the supervisor and student is to have effective supervision throughout the entire period of candidature in engineering postgraduate supervision.   In our particular case presented we compared with standard benchmark shown in Table 8.   It is obvious that if the holistic supervision is effective, the outcome is significant.   In our case, some main results are listed in Table 8.

Table 8: The comparison of effective supervision with the benchmark

Requirement	Timing	Benchmark	Our Case
Enrolment	Before the start of each semester	Meeting once for an interview	Meeting three times: • Interview • Research proposal for application • Final edition for submission
Learning plan	Within 3 months of commencement of research phase. Reviewed by candidate and supervisor at least annually	2 to 3 months	2 months
Final research proposal	As soon as possible and certainly before the initial seminar where it will be handed in for assessment	5 to 6 months	4 months
Ethics approval	As soon as you know what you are doing – definitely before starting the research	NA	NA
Initial seminar	Within 6 months for full time students	6 months	5 months
Annual Progress Report	Each year (around September to October)	Done as requited (3: satisfactory)	Done as requited (4: good and 5: very good)
Second work-in-progress seminar (PhD only)	In second year (for full time students)	NA (this case)	NA (this case)
Conference	Anytime during	Once (Master by	2 (for his Master

attendance/presentation	candidature	research)	by research)
Publication	Anytime during candidature	1-2	4 papers (one in journal, 3 in IEEE conferences)
Final seminar	When the thesis is finished or about to be finished	About 2.0 years when the thesis handed in	1.8 months
Submission of thesis for examination	Within 4 years for PD and PhD students-2 years for Masters students	About 2.0 to 2.5 years when the thesis handed in	1.8 months
Submission of final copies of thesis	After examination and when required changes (if any) have been made	About 3-6 months	No further work needs due to very positive results

Since John had been working smoothly with his Master by research and found his experience stimulating in this School, John has decided to pursue his PhD in next year.

Conclusion

In this paper we focus on effective supervision for postgraduate research student, via a case student in engineering. The experience presented here includes three aspects (1) nature of postgraduate research student and supervisor, (2) knowledge of expectations, and (3) effective communication channel are not just for software engineering supervision but also for all research postgraduate engineering supervision. This can even be extended to other disciplines. We hope the case study can underpin the statements about the descriptions of the supervision of postgraduate research students.

References

Brown, G. & Atkins, M. (1988). *Effective Teaching in Higher Education*, London: Methuen.

Clark, J. (1996). Postgraduate skills: A view from industry. Paper presented to the Deans of Graduate Studies, Sydney

Enhancement of Learning, Teaching and Scholarship, http://www.canberra.edu.au/celts/QPR

Kiley, M. (2003). Quality in Postgraduate Research. Retrieved from http://www.canberra.edu.au/celts/QPR

McCormack, Coralie (1998), *A Guide for Supervisors*, University of Canberra, Centre for the

Mullins, G. and Kiley, M. (1998). Quality in postgraduate education: The changing agenda. Quality in Postgraduate Education: Managing the new agenda. M. Kiley and G. Mullins. Adelaide, The Advisory Centre for University Education: 1-14.

Parsloe, P. (1993). *Supervising Students for Higher Degrees by Research in a Social Work Department*, Journal of Further and Higher Education, Vol. 17(2), 49-60.

Powles, M. (1994). Postgraduate Supervision. Melbourne: University of Melbourne, Centre for Study of Higher Education.

University of Canberra [2006], The little gold book, A post-admission guide for UC postgraduate research students, Office of Research and Research Degree.