Access, reward and penalty: the art of supervision at the (post)graduate level, a case study of an electrical engineering laboratory

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Abstract

Supervision of graduate students is becoming an increasingly important area of focus and scholarship. An example of the efflorescence of theory and pedagogy of supervision in Australia and other Commonwealth countries is the tertiary-level institutionalisation of programs which serve to accredit individuals in the complex art of supervision. But while scholarship of graduate-level supervision in the humanities and social science grows exponentially, basic discourse regarding method and practice of supervision of graduate level engineers is largely lacking. The author employs ethnomethodological techniques to explore and address this undertheorised area of engineering pedagogy from the point of view of a *supervisor* of number students in electrical and electronic engineers. The paper specifically explores a basic pedagogical structure in a laboratory of higher degree research (HDR) electrical engineering students, defines a complex time-based and proximity reward system the supervisor uses to prompt students to achieve excellence, and theorises an ethical way of dealing with poor student performance.

1. Introduction and Background

The title of this paper is derived from Grant [1, p. 3] who notes "…there is the material reality of the supervisor's more powerful structural position and the ways in which this position can be used to block access to privilege and reward…". To follow, graduate level engineering education might consider two interrelating and acting subjects, the supervisor and the supervised. Two recent studies [2, 3] quantitatively assess the murky issue of supervisor satisfaction from the student point of view. While a qualitative study of both the supervisor and supervised underpins the authors' larger study, this paper primarily considers the point of view of the supervisor and surrounding theory and practice of his supervisory experience in electrical engineering. Interview data and examples model a specific case.

The purpose of this paper is three fold: (i) to explore a basic pedagogical structure in a laboratory of higher degree research (HDR) electrical engineering students, (ii) to define a complex time-based and proximity reward system the supervisor uses to prompt students to achieve excellence and, (iii) to theorise an ethical way of dealing with poor performance. The paper is divided into five sections. The first of these, presents introduction and background

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material focusing upon data and data collection methods as well as giving brief contextual details about the study. The second section, **Access Levels**, explores the fundamental ways the supervisor inducts students into the discipline of research in signal processing. The third section, **Reward**, defines a 31 stepped continuum of special tasks or events which bring the student, in a centripetal fashion, closer to the professional life of the supervisor. The fourth section, **Penalty**, posits a novel concept, generational modeling, which deals with intricate ethical teaching dilemmas. A brief conclusion summarises the contributions of the paper and suggests areas for future research.

1.1 Background

The focus of this paper is the supervisory practice of an academic whose supervisory career spans more than a decade in time, three separate university laboratories in two continents, and the lives of 35 higher degree research (HDR) students. Generally most of the students work(ed) in a more theoretical area of electrical and electronic engineering known as digital signal processing. Their investigation primarily involves mathematical modeling using high powered computing facilities and statistical methods for signal processing such as signal detection and parameter estimation.

The following paragraphs describe two data areas from which I observe the concepts of access, reward and penalty as applied to the laboratory of students. While the two data areas seem distinct, and I am distinct from them, in fieldwork, the delineation between researcher and researched often is blurred. So while most of the data is collected, transcribed and organised in a systematic way, the sustained relationship I have with approximately 20 of the students, suggest a far richer and deeper narrative drawn from personal experience and observation. All names are pseudonyms.

1.1.1 Higher degree research (HDR) students. The primary information source is a set of 26 field notes collected in 2003 over a period of three months of participant observation where I was situated in a laboratory in a Western Australian university with eight full-time PhD students who study related aspects of digital signal processing and are supervised by Prof Yahia. Following the observation period, I devised 20 semi-structured interview questions to collect information about the complex nature of the community in which the students work. Subsequently, I interviewed the students and transcribed the interviews. The students were/are in various stages of progress – from new students to nearly completed students. Three of the eight students are Australian and the remaining five are international students. All students have undergraduate degrees and in some cases Masters degress in electrical/electronic engineering. In a second round of data collection one year later, I revised the interview questions slightly and re-interviewed the same students, though one student did leave the group. Further, I surveyed and interviewed, with the same 20 question instrument, additional PhD students who formed a European laboratory set up by Prof Yahia.

1.1.2 Supervisor. The secondary information source are interviews with the supervisor, Prof Yahia, which were undertaken a year after he departed from the Australian laboratory to take a position in a European institution, and subsequent conversations relating specifically to the concept of access, reward and penalty. The supervisor has graduated 8 PhD students and 1 Masters student as principal supervisor, he has 3 students who shall complete by 2006. Further, he has been a defacto supervisor for 11 students and associate supervisor for 7 students. Five students, not counted in the above total, failed to complete.

The data, as noted above, was gathered from direct observation and interviews, and from it I

derive three key tenants of Prof Yahias' supervisory practice: access, reward and penalty. The following three sections illustrate each tenant. Within the access category, four separate control points of supervision are noted and discussed with examples. Next, student reward levels are ordered by rank and over time as the supervisor induces exceptional students in a centripetal fashion to a community of practice [4]. Finally, the concept of denial of access and reward (ie penalty) within the community is discussed, with a particular emphasis on a new concept entitled **generational modeling** which seeks to address ethical concerns raised when dealing with issues such as denial.

2. Four level access

The laboratory where I undertook my observations is located within a Department at a large institution in Australia. The students all sit at workstations in a large partitioned office area. Each student has a desk, chair, and a PC as well as access to: a large unix server for running simulations, a telephone, a laser printer, a seminar room (doubling as a lunch room) and a small kitchen. Prior to forming the laboratory in Europe, the supervisor, Prof Yahia, had relatively standard ties with the international community, several research grants, an active teaching schedule and administrative duties and close ties with a Co-operative Research Centre (CRC). The physical structure of the laboratory, however, seems of less importance than the virtual organisation of a large number of PhD students. Prof Yahia strongly adheres to a belief that a PhD in statistical signal processing is not achievable under 4 years, so the tenure of students is a minimum of four years. Further to that, students are grouped based on length of service—starters (1-2 years), mid-fielders (2-3 years), and near-finishers (3-4 years). This time-division facilitates the supervision of a large number of students at different stages of completion. The position of the student in the 'field' suggests the level of access, but more importantly, the reward level that is appropriate. How this works in practice shall become clearer as I untangle the complexity of the access levels, below.

I define access levels as the basic points at which Prof Yahia instructs, facilitates, or mitigates. Taken together, they form invisible protocols governing most aspects of the student experience. The four access levels listed below in column 1 describe the broad areas of access were the supervisor acts as gatekeeper or access point to facilitate or deny student involvement. The descriptors in column 2 are denoted with an arrow to indicate the dynamic nature of the interactions, and between what or whom they primarily exist at that level.

1.	2.
Access area	**Primary interaction type controlled by supervisor**
Environment access	Student ↔ environment
Learning access	Student ↔ supervisor
Institution access	Supervisor ↔ organisations
Community access	Supervisor ↔ supervisor peers

Each access area is described below in sections 2.1-2.4 and illustrated in tables 1-4.

2.1 Student « environment

Informal environment Social, religious, cultural gatherings Administrative **Laboratory environment** Desks/Office space Equipment Staff Academic staff Research staff Administrative staff	**Environment of opportunities** Supervise others (ie final year project) Seminars Technical meetings Colloquia

Table 1. Environment access

Table 1 indicates areas where the supervisor acts to facilitate access to basic facilities and opportunities of graduate students. For example, while new and mid-field students all sit in the partitioned main laboratory area, near finishers often are given separate offices and more access to staff. Accomplished students who have both the time management and English skills are allowed to supervise final year projects. Denial of access at this level may mean something as simple as not allowing a student to present work in a technical meeting until all details of an idea are modeled mathematically and with simulation software and fully rationalised to the satisfaction of the supervisor. Additionally, the importance of the social environment cannot be diminished when inducing new students to the culture of the laboratory. For example, the inclusion of all students in laboratory gatherings for birthdays, thesis completions and acceptances of papers to important journals or conferences are key ways the near-finishers include starters in the routine social experiences of laboratory life.

2.2 Student « supervisor

Direct communication of knowledge Indirect communication of knowledge Support of ideas Allows paper publishing Equipment & Facilities Techniques Discipline based Research writing, conference presentation Methods	"Opportunities" Research grants Tutoring Administration Funding Stipends Conferences

Table 2. Learning access

Table 2 illustrates several learning or knowledge access levels. The most basic level of knowledge facilitation is via one on one tutorial instruction, a technique the supervisor used early in his supervisory career but employed less and less as he found more efficient ways of directing student learning, particularly as he became a more popular supervisor and more involved in administration and international travel. Increasingly larger student numbers found Prof Yahia giving new students some basic journal articles to read initially, for example, but letting the other more senior members of the laboratory handle the day to day basic tutelage in signal processing techniques. As Lave & Wenger [4, p. 93] note: "There is anecdotal evidence that where the circulation of knowledge among peers and near-peers is possible, it spreads exceedingly rapidly and effectively."

Most students are supported via some funding from the supervisor, but those who are adept authors with innovative ideas are allowed to present their work more frequently to peers, but moreover to external communities. In this way, Prof Yahia facilitates adequate internal mentoring of all students and presents opportunities outside of the laboratory to only those who he feels are appropriate lecture tutors or research assistants on external research grants as these are visible reflections of the quality of research undertaken within the lab. A student who attends only one conference during his/her period in the lab is a student under strict control.

2.3 Supervisor « organisations

Internal	**External**
Administrative	Governmental & Non-governmental
Candidacy	Ie. Defense Science & Technology Org.
Defense	Royal Woman's Hospital
Examiner choice	Universities
Centres/Research Co-operatives	Exchange
	Australian Research Council

Table 3. Institution access

Table 3 indicates institutional access. Prof Yahia has very early, internal control over the candidacy, for example, and can effectively not allow the student to pass candidacy after a candidacy seminar. Similarly, he can facilitate an easy or hard examination process based upon thesis examiner choice. The supervisor chooses to allow the student to be a part of co-operative research centres, can facilitate external exchanges, secondments, or placements within industry or on research projects as a named researcher.

2.4 Supervisor « supervisor's peers

Publishing	Positions
Editorial	Referrals/Referees
Reviewing	Postdoctoral positions
Writing	Research grants
Network	
Conferences	
Writing	

Table 4. Community access

The final category, community access, is the most important access level because it is at this level that the supervisor controls the future of the student by allowing or denying access to the community of the supervisors' peers. Prof Yahia involves most students in reviewing , for example. This includes the review of papers for conferences, workshops and symposia. Equally, the supervisor encourages most students to publish at least once prior to completion of the doctoral degree in an internationally referred journal. The supervisor frequently funds students for conferences, but rarely speaks of 'his brilliant student Gopal'. He admits at conferences he makes an effort to introduce his students to others working in the particular area of signal processing, but he does not go out of his way after brief initial introductions. He encourages students to obtain positions in academia and signal processing related fields, frequently providing verbal or written references.

3. Reward, a time-based, proximity continuum of supervision

Similarities exist between the apprentice model of learning as discussed in Lave and Wenger[4] and the modeled learning as suggested above in the laboratory of PhD students. Much like the midwives and tailors, for example, engineers practice their art through careful observation of others, one of whom is the supervisor (or master) himself. In the story of the Vai & Gola tailors for example, simple items such as hats are made before apprentices are even allowed to touch the fabric for cutting. In this way, the master controls potential damage, but also the level of exposure of the apprentice to increasingly wider, more sophisticated, circles. A supervisor of postgraduate engineering students would do similar in controlling the time to complete and scope of the thesis, first allowing students to present ideas at technical meetings, and later at seminars or conferences, and finally in writing in the form of a journal paper. However, laboratory supervision has a proximity dimension which manifests itself in a centripetal motion, aligning and drawing students closer and closer to the supervisor's life amidst a community of signal processing academics.

Beyond basic thesis research and writing, exceptional students in the laboratory are rewarded with increasing (in number and complexity) tasks or rewards as assigned by the supervisor, including advanced tutoring, detailed administrative tasks, early publishing and ultimately, work on new research grants, projects and books. All of these tasks actually serve to bring the students closer to the supervisor, and it is for this reason that students in the group engage in approval seeking behaviour such as presenting new ideas and techniques. The supervisor is careful to note such behaviour, and only responds with reward to those who can articulate their ideas well in writing, or prove themselves capable at lower level tasks. I observed much of the following in my field work with the students. However, upon discussion of reward, the supervisor himself has added several categories and ordered the list. The supervisor agrees that some of the tasks seem trivial in nature, but argues that they serve students by providing extra challenges and facilitating special knowledge of the discipline –again, drawing the student closer to the orbit of the supervisor himself. I note that half of the 30 students don't achieve past the first 10 reward levels, highlighted below.

Higher Degree Student:	Is research assistant on grants
Assists with tutorials/practicals	Is external media liaison
Undertakes marking	Multiple conference attendances
Delivers tutorials/practicals	Is named researcher on grants
Assists with simulations	Has lengthy secondment
Assists with reviewing	Writes a chapter
Undertakes administrative tasks (website, server, data collection)	*Post-doctoral, Prof Yahia:*
	Provides a verbal reference
Conference organization	Provides a written reference
Assists with writing paper	Provides post-doc appointments
Assists with grant writing	Seeks joint publications
Presents others' work at conferences	Nominates or supports personal awards & promotion
Writes exam questions	Requests postdocs to
Is named paper reviewer	examine others theses
Delivers lecture	serve on conference panel
Co-authors paper	(technical, organisation, publishing)
Write lectures, slides for external presentation	Admits the post-doc to the lobby
	Co-authors book(s) with the former student

Table 5. Levels of reward, with increasing proximity to Prof Yahia over time

In Table 5 above, most of the criteria require little discussion. Obviously the apprentice/students' time with Prof Yahia lays a foundation for what occurs *after* receipt of

the higher degree qualification. Note for example in Table 5, column 2, the trend becomes much less of what the student can do for the professor, and much more of what the professor can do for the student, especially in the post-doctoral period. At present, for example, two former students are now full-time post-docs in Prof Yahia's laboratory in Europe and at least one student has progressed through all 31 levels of reward and indeed is considered a peer, in the same academic and professional orbit, as the supervisor.

Certainly, the longer tenure (by Australian standards) of a four year PhD allows students a thorough apprenticeship in terms of both access and reward. Equally, the supervisor is able to retain a somewhat longer period of 'critical mass' thus benefiting both. The benefit for all students, even those who do not wish to pursue a career in academia is clear. When asked, all students uniformly felt they would not change pedagogical aspects of their PhD.

4. Penalty and denial: Ethics in communities of practice

Obviously it is much more beneficial for the laboratory students and the supervisor to have productive and eager students. However, even in adult communities, this halcyon scenario is not always possible. This section deals with the mechanism the supervisor employs for inadequate performance. I suggest it is a form of penalty where the supervisor: denies *one* or *more* levels of access, denies *one*, *many* or *all* rewards or disallows completion of the thesis. Certainly, I witnessed lab students who, at various times experienced denial of access and reward. For example, one student repeatedly tried to demonstrate his superior research skills by continually introducing new, and arguably under-theorised, ideas at technical meetings. After several open and humiliating exchanges, the student attained a greater access level, publication of his work, by putting much more emphasis on the writing and simulations which backed his claims in presentations. Many educational theorists have recognised dilemmas faced by teachers in standard classrooms. Wallace notes, for example:

> …teachers must exercise power *over* others in order to achieve their pedagogical goals. It would seem that these two forms of action – power with and the power over – are held in constant dialectic tension. Freedom, according to Shor and Freire (1987), cannot be found in the absence of authority. Hence the promotion of freedom for self and for others often requires the exercise of power and the act of teaching means knowing how, why, when, where and for how long to exercise that power [5, p. 110].

But this raises important ethical questions. How is penalty accommodated in a post-modern world, where human research ethics committees say *do no harm* and where each act of supervision comes increasingly under scrutiny? Moreover, how can I stand by as a researcher and record what appears to be denial of access and reward? The answer to this can be found in a principle I call generational modeling as described in section 4.1 below.

4.1 Generational modeling

I define generational modeling as an ethic of practice derived in part from communitarianism, communities of practice and habitus in the following way. Christians [6, p. 147] notes of communitarianism: "Moral duty is nurtured by the demands of social linkage and not produced by abstract theory." Bourdieu, in his careful study of the Kabyle, similarly captures the concept of kinship and social linkages in his discussion of the fundamental principles of societal replication:

> There is silent observation of the discussions in the men's assembly, with their effects of

> eloquence, their ritual, their strategies, their ritual strategies and strategic uses of ritual. There are the interactions with their relatives, which lead them to explore the structured space of objective kin relationships in all directions by means of *reversals* requiring the person who saw himself and behaved as a nephew of his father's brother to see himself and behave as paternal uncle towards his brother's son and thus to acquire mastery of the transformational schemes…and which instill the sense of the interchangeability of positions and of reciprocity as well as sense of the limits of each[7].

Generational modeling describes an ethic of practice in a learning community where individuals are allowed legitimate peripheral participation [4] but where hierarchical relationships are implicit. A simplistic realisation of generational modeling is the way in which matriarchs or patriarchs raise children. This can be witnessed especially in larger families, where meeting the needs and demands of the individual children must be balanced by the limitations and requirements of the whole. In more traditional realisations, the family is situated socially and culturally within extended kinship structures. New generation familial structures seek to improve upon the way they have been raised as well as respond to modern demands. But the way in which offspring are raised is still a deeply imprinted template, modeled from parental and kinship relationships. This relates to a learning community in a similar way to Lave and Wengers' alcoholics anonymous old-timers, sponsors who '…reportedly withhold advice and instruction appropriate to later stages…until the newcomer becomes "ready" for a next step through increasing participation in the community'[4, p. 92].

In generational modeling, hierarchy is implicit and ethics takes upon a new facet. The concept of denial is reconceived as a gradual process of gaining access and reward. In the familial example, parents nurture children individually, building strengths while taking account of weaknesses and developmental capabilities. Similarly, the supervisor has the full knowledge of capabilities and limitations of the students, and will always control access and reward as a function of progression. In simple generational modeling, a parent, while nurturing, also controls risk. A watchful mother keeps toddlers away from a hot saucepan, though the burn may produce the desired effect of aversion to the stove. Much in the same way, the supervisor controls the risk of potential harm by the student to him/herself. Ethics, again, is not an issue because denial controls unacceptable risk.

Unlike the simple family analogy, however, the supervisor also controls potentially risky business which may either damage **his** reputation or negatively effect other students. Much like the Vai tailors in Lave & Wenger, the student is ushered into the community in a stage-wise fashion, with low-risk (perhaps even trivial) tasks completed initially, followed by increasingly more costly undertakings. Ultimately, the apprentice relies upon the blessing of the master: "Apprenticeship is their daily life and at the close of the apprenticeship the new master must receive the official blessing of his master before he can begin a successful business independently" [4, p. 67]. Therefore generational modeling is a far more complex relationship than parent-child, as it deals with the control of risk within the practice in a community, and the blessing of an apprentice to go forth. As Christians notes:

> Communities are woven together by narratives that invigorate their common understanding of good and evil, happiness and reward, the meaning of life and death. Recovering and refashioning religious word forms help to amplify our deepest humanness[6, p. 147]

Certainly, generational modeling practice in a community is as much knowing (nature/theory) as it is about doing (ie nurture/practice). The supervisor who is the focus of this study has ushered 30 students to completion, but it is not merely from practice that he derives his

expertise. He has two important figures from which his expertise is modeled. The first of these and perhaps the most influential is the supervisors' own father and family where he is one of nine children with a very large extended kin structure of uncles, cousins and aunties. He is thus uniquely positioned to learn from his own father the tenuous balance of control, discipline, and nurturing in a patriarchy. Additionally, the supervisor himself was supervised by an internationally renowned figure who has also ushered 35 higher degree signal processing students to completion (where candidacy length = 5 years). In sum, the supervisor derives his legitimacy and success not only from his practice, but from his own generational habitus as defined by Bourdieu:

> …the habitus, the product of history, produce individual and collective practices, and hence history, in accordance with the schemes engendered by history. The system of dispositions – a past which survives in the present and tends to perpetuate itself into the future by making itself present in practices structured according to its principles…is the principle of continuity and regularity… in the social world[7, p. 82].

Empowered with legitimacy based upon generational modeling, Prof Yahia impels students in a way which a) encourages performance excellence, b) encourages laboratory replication in the post doctoral experience and c) controls risk d) in fact minimises penalty by focusing on increasing reward structures. As noted above, the ultimate penalty for a student is non completion of a thesis, and this the s ubject of the final portion of Section 4.

4.2 Thesis non-completion

I reported in the beginning of this paper that the supervisor influenced the lives of 35 students. Five of those students did not complete due to withdrawal from study early in candidacy. Students who voluntarily separated from the laboratory were not a part of my study, so I have not interviewed any of the five. However, several months before John left the laboratory he reported to me his dissatisfaction with teaching and academia in general:

> Tanya: Let's just reflect to your future…what's the most probable employment for you?
>
> John: Well, I don't think it is academic, as in teaching. I like the things that I have done. So that could be an avenue, there are other avenues that I have experienced. That is the thing with the PhD you are focused on things, but in the first year you have experienced a lot of different things and so my ideas of what I might do in the end are changing so uhm. There could be defense work, there could be uh work with the internet, there could be all sorts…there could medical or biomedical things that could come up…all sorts of things. I don't know. I really don't know. That is also a problem with uhm…this city…well I have a few more constraints on me…I've got ties here and things I want to see stuff so in the end uhm it is…[trails off]
>
> Tanya: So what do you see yourself doing in 5 years?
>
> John: I don't. I don't know. I don't at all. Uhm I am very open to the fact that people change their jobs every 3-5 years anyway…uhm you can find things…I expect in the workforce you do that…that you experience different trades things lik e that to see what you do like. I don't think I would project though.

In other interviews I conducted, the students routinely suggested they would be teaching or working in industry directly utilising their PhD in signal processing. This suggests that John failed to have his needs and aspirations align, unlike the other laboratory students, in centripetal motion path toward the supervisor. The supervisor reported he did not have a

thesis he supervised to completion fail the examination process and in fact, approximately 28 of the 30 student cohort are currently employed in academia or industry directly relating to signal processing and electrical/electronic engineering.

5. Conclusion & significance

Much of the scholarship in this paper is tacit knowledge, knowledge that the supervisor has gained through his experience in supervising a significant number of students, both as the named supervisor and as defacto! While it was not the intention of the paper to explore the codified knowledge of student/supervisor practices extant at the institutional level and readily available at the websites of most of the 38 institutions within Australia[8], it is important to recognise the importance of ever changing codified knowledge and its potential effect upon supervision 'at the chalk face'. The aim of this cross disciplinary research is to embrace qualitative methods to articulate the case of a particular laboratory-based supervisor, working in both Australia and Europe. Significantly, two new concepts, a time-based proximity continuum and generational modeling are introduced to describe phenomena of dualistic concepts of reward and penalty in postgraduate supervision. Further discussion and analysis of specific reward levels, mapping each to the 35 students of the supervisor, is suggested.

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Biography

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