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**Research and Teaching at Doctoral Level : is there a link?
(La recherche et l'enseignement au niveau du doctorat : y a-t-il
une relation?)**

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Title:**Research and Teaching at Doctoral Level: is there a link?*****Abstract:***

The production of PhDs has recently attracted much attention from higher education policy makers and universities. This paper aims to investigate the relationship between staff research and teaching in doctoral education with a special reference to disciplinary variations. A questionnaire composed of two major dimensions of doctoral education – Supervision and Research environment for doctoral students – was distributed to about 2,200 full-time doctoral students in Education and Chemistry in UK universities. The relationship between staff research (the 2001 RAE scores) and the effectiveness of doctoral education as perceived by students is analysed along the above dimensions. Follow-up interviews were also conducted with students.

On the whole, little relationship between departmental research performance (the RAE scores) and effectiveness of doctoral education is found in Education and Chemistry, especially pertaining to the aspects of supervision. However, the results of research environment are more complex. Although the general findings of a lack of a significant relationship between research and teaching apply to both Education and Chemistry departments, it is interesting to note that doctoral education is more favourably perceived by doctoral students in Chemistry than in Education. Finally, a theoretical diagram of Teamwork and Individualist research training structures in Ideal and Degenerative types to discuss these findings is generated.

Key words: Higher education, Doctoral programmes, Student experience, Research, Publish or perish issue, Teacher effectiveness. (Eric Index)

Introduction

The relationship between teaching and research has been a controversial issue in higher education (Horlock, 1991; Barnett, 1992, 2000; Hattie & Marsh, 1996; Harris Report, 1996; Elton, 2000; Rowland, 2000a, 2000b; Marsh & Hattie, 2002; Brew, 2003; Menon, 2003). The relationship matters partly because of its implications for the structure and resources of higher education and partly because of its intrinsic importance in helping to define higher education, especially the role of university. More pragmatically, the nature of the relationship bears on the quality of university education.

Unfortunately, very few empirical studies on this topic were driven from students' perspective (Lindsay et al., 2003), particularly at the doctoral level when the relationship between research and teaching become an essential issue. To satisfy this need, this study aims to investigate the relationship between staff research and teaching in doctoral education from students' perspective with special references to disciplinary variation. The first part of this research concerning the learning experiences of PhD students in the UK found that Chemistry departments are seen as offering better doctoral education as perceived by students than Education departments. A theoretical framework of Teamwork and Individualist research training structures to interpret the findings is developed. (Chiang, 2003) With regard to the link between research and teaching, bearing in mind the above findings (*ibid.*), the question now becomes: what kind of relationship between research and teaching in Chemistry and Education can be, if Chemistry doctoral education is perceived to be better than Education? And what does the relationship mean to the Teamwork and Individualist research training structures in Chemistry and Education? Therefore, this paper will examine the relationship between research and teaching in doctoral education by taking into account the disciplinary differences in students' learning experiences in the two subjects (*ibid.*).

Background - Relationship between Research and Teaching

The claim that staff research will enhance teaching and learning has been revealed in many places, such as The Robbins Report (1963):

There is a reciprocal benefit to those engaged in research from being members of an institution where learning is not only advanced but communicated. Contact with able and lively young minds, and the setting of the teacher's own preoccupations in a wider context which the preparation of lectures demands are of positive use as well as a source of refreshment. (ibid.: para. 556)

More recently, Horlock (1991) asserted that every university teacher needs to do research. He claimed "if the quality of university teaching is to be high class, alive and exciting, then academic staff must be closely in touch with research and scholarship, with latest developments in their subjects." (ibid.: 78) It is argued that teachers cannot be at the 'frontier of knowledge' unless they are active researchers. The mutual reinforcement between research and teaching is accentuated.

A contrasting view contends that because of the scarcity of time, energy and commitment, research and teaching are more likely to interfere with each other rather than enhance each other. Linsky and Straus argued that "only so much time and energy is available to any one person and commitment to either [role] prevents the development of excellence in the other role." (1975: 91) Barnett (1992) contended that the nature of research and higher education are diverse along six dimensions. For example, research is more public for its attempt to produce objective knowledge, while higher education is more private for its concern is related more to what is going on in the mind of the individuals. Research is more about outcome because results count for everything, while higher education concerns more about the process because learning is a process of self-development. Faia (1976) discussed the degree of similarity between the roles of researcher and teacher by comparing them along four dimensions: time, specialisation, the notions of creation and diffusion of knowledge, and rewards. His argument is that "the greater the disparity, the less the complementarity." (ibid.: 241) He found that these two roles are not complementary in many aspects.

Yet focused, evidence-based, attention to the relationship has been relatively rare especially at the level of doctoral education. Moreover, there are few studies on staff research from student's perspective. Although Hargens (1975) showed that a strong association between numbers of graduate students and research productivity is found in Chemistry, but not in mathematics and political science (cited in Kyvik & Smeby, 1994), issues like the relationship between staff research and research students' learning, and research students' perception of the link between teaching and research are largely unknown and need investigation.

Research Methods

Measure of Teaching

Education and Chemistry were selected as a representative subject of social sciences and sciences. The learning experiences of full-time PhD students in 28 Education and 31 Chemistry departments across UK were surveyed. More than 2,200 questionnaires were distributed and over 1,100 were returned. The response rate for Education was 80.9%; for Chemistry 41.3%; an average of 50.5%. It is interesting to note the high response rate from Education students and the relatively low response rate from Chemistry students. The possible reasons for this will be discussed later.

Six main questions were generated to measure the effectiveness of supervision at the individual level in doctoral education. Among them, the fifth question is treated as the general evaluation of the effectiveness of supervision. At the aggregate level, seven major questions are generated to explore the quality of the research environment for doctoral students in helping them finish in time and in preparing them as good researchers. All the questions ask students to choose from 1-7: 1 as least favourable, 7 as most favourable. Apart from those questions, background information such as gender, domicile, subject and department was also collected.

Eight interviewees, four in Education (A, B, C, D) and four in Chemistry (F, G, H, J), were chosen from students who left their correspondence details in the questionnaire. Among these four students in each subject, two of them, A & B in Education and F & G in Chemistry, were chosen from institutions with high RAE scores such as 5 or 5*. Another two of them, C & D in Education and H & J in Chemistry, were from institutions with low RAE scores such as 1, 2, or 3b.

Measure of Research

About the departmental research performance, the scores of the 2001 Research Assessment Exercise (RAE) in Education and in Chemistry were used. The range of the scores is from 1 to 5* (HEFCE, 2001) to assess departments across disciplines. The meaning of each score, according to the Higher Education Funding Council (ibid.), is presented in Table 1. For statistical analysis, these were transformed to score 1-7. For example, if a Chemistry department or an Education department is rated as 3a, it means that those two departments are more or less in the same group of research performance: “Quality that equates to attainable levels of national excellence in over two-thirds of the research activity submitted, possibly showing evidence of international excellence”. (see Table 1)

Table 1: Meanings of the RAE Scores

5*	Quality that equates to attainable levels of international excellence in more than half of the research activity submitted and attainable levels of national excellence in the remainder.
5	Quality that equates to attainable levels of international excellence in up to half of the research activity submitted and to attainable levels of national excellence in virtually all of the remainder.
4	Quality that equates to attainable levels of national excellence in virtually all of the research activity submitted, showing some evidence of international excellence.
3a	Quality that equates to attainable levels of national excellence in over two-thirds of the research activity submitted, possibly showing evidence of international excellence.
3b	Quality that equates to attainable levels of national excellence in more than half of the research activity submitted.
2	Quality that equates to attainable levels of national excellence in up to half of the research activity submitted.
1	Quality that equates to attainable levels of national excellence in none, or virtually none, of the research activity submitted.

(HEFCE, 2001)

Results

Regression analysis of correlation between staff research (the RAE score) and teaching (as perceived by PhD students)

The results of multiple regression analysis of the three components in supervisory effectiveness with the 2001 RAE and other variables are presented in Table 2, 3 and 4.

Table 2 shows that when other variables are hold constant, the 2001 RAE is not related to supervisor's facilitation of learning. Significantly, supervisor's facilitation of learning is more favourably perceived in Chemistry than in Education. Also, Asian students and senior students are less satisfied with supervisor's facilitation of learning than non-Asian students and junior students.

Table 2: Multiple Regression for Predicting Supervisor's Facilitation of Learning with 2001 RAE

<i>Supervisor's Facilitation of Learning</i>	Beta	T	Sig.
<i>2001 RAE</i>	-.02	-.06	.55
<i>Subject (Edu: 1; Che: 0)</i>	-.11	-3.11	.00
<i>Year of study</i>	-.16	-4.76	.00
<i>Asian students (Asian: 1; Others: 0)</i>	-.17	-4.89	.00
<i>Gender (Female: 1; Male: 0)</i>	.03	.85	.34
Model Summary: R Square (Adjusted R Square)		.09 (.08)	

The multiple regression of supervisor's accessibility with the 2001 RAE reveals similar results (Table 3). Having taken account of other variables, the 2001 RAE slightly negatively contributes to supervisor's accessibility. As already noted, the disciplinary factor contributes to the differences of perceptions on supervisor's accessibility. Supervisors are perceived to be more accessible in Education than in Chemistry. Students with English as foreign language and senior students are less satisfied with supervisor's accessibility than students with English as mother tongue or the second language and junior students.

Table 3: Multiple Regression for Predicting Supervisor's Accessibility with 2001 RAE

<i>Supervisor's Accessibility</i>	Beta	T	Sig.
<i>2001 RAE</i>	-.08	-2.33	.02
<i>Subject (Edu: 1; Che: 0)</i>	.13	3.56	.00
<i>Year of study</i>	-.11	-3.22	.00
<i>English as foreign language*</i>	-.13	-3.62	.00
<i>Gender (Female: 1; Male: 0)</i>	.04	1.23	.22
Model Summary: R Square (Adjusted R Square)		.05 (.04)	

(* English as foreign language: 1; English as mother tongue or the second language: 0)

Table 4 shows that the 2001 RAE has little bearing on relevance of supervisor's research to student's. It also reveals the disciplinary effect. Education supervisor's research is slightly less relevant to student's than Chemistry supervisor's research to that of students. Also supervisor's research is perceived to be less relevant by female students than male students.

Table 4: Multiple Regression for Predicting Relevance of Supervisor's Research to Student's with 2001 RAE

<i>Relevance of Supervisor's Research to Student's</i>	Beta	T	Sig.
<i>2001 RAE</i>	-.01	-.27	.79
<i>Subject (Edu: 1; Che: 0)</i>	-.09	-2.27	.02
<i>Gender (Female: 1; Male: 0)</i>	-.12	-3.30	.00
<i>English as mother tongue*</i>	-.02	-.52	.60
<i>Asian students (Asian: 1; Others: 0)</i>	-.03	-.63	.53
<i>Year of study</i>	-.00	-.00	.95
Model Summary: R Square (Adjusted R Square)		.03 (.02)	

(*English as mother tongue: 1; English as foreign or second language: 0)

The results of multiple regression analysis of four components of effective research environment for doctoral students are presented in the following tables. To avoid repetition, the separate results of Education and Chemistry are presented only if there are discrepant findings between the two subjects.

Table 5 shows a contrast between Education and Chemistry related to academic culture of social interaction. The most remarkable result is that the effect of the 2001 RAE only exists in Chemistry, but not in Education. Academic culture of social

interaction is perceived to be less satisfactory in Chemistry departments with higher RAE scores. Senior students, regardless of their subjects, are less satisfied with academic culture of social interaction than junior students. Asian students in Education, but not in Chemistry are less satisfied with academic culture of social interaction than non-Asian students.

Table 5: Multiple Regression for Predicting Academic Culture of Social Interaction in Education and in Chemistry with 2001 RAE

Academic Culture of Social Interaction	Education			Chemistry		
	Beta	T	Sig.	Beta	T	Sig.
2001 RAE	.01	.19	.85	-.16	-3.85	.00
Year of study	-.14	-2.50	.01	-.13	-3.21	.00
English as mother tongue*	.05	.82	.41	.08	1.84	.07
Asian students (Asian: 1; Others: 0)	-.12	-2.02	.04	-.08	-1.74	.08
Gender (Female:1;Male: 0)	-.09	-1.65	.10	-.01	-.27	.79
Model Summary: R Square (Adjusted R Square)	.05 (.04)			.07 (.06)		

(*English as mother tongue: 1; English as foreign or the second language: 0)

Table 6: Multiple Regression for Predicting Intercultural Facilitation of Research (for Foreign Doctoral Students) with 2001 RAE

Intercultural Facilitation of Research	Beta	T	Sig.
2001 RAE	.03	.60	.55
Subject (Edu: 1; Che: 0)	-.16	-3.19	.00
English as mother tongue*	.12	2.45	.02
Asian students (Asian: 1; Others: 0)	-.21	-4.41	.00
Year of study	-.08	-1.65	.10
Gender (Female:1;Male: 0)	-.02	-.45	.66
Model Summary: R Square (Adjusted R Square)	.13 (.11)		

(*English as mother tongue: 1; English as foreign or the second language: 0)

Table 6 gives some details of intercultural facilitation of research for foreign doctoral students when the 2001 RAE is taken into account. As might be expected, the 2001 RAE is not related to intercultural facilitation of research. Again, there is a disciplinary effect. Intercultural facilitation of research is more favourably perceived by foreign doctoral students in Chemistry than in Education. Moreover, foreign students with English as mother tongue and non-Asian students are more satisfied

with intercultural facilitation of research than foreign students with English as foreign or the second language, and Asian students.

It is interesting to note that the 2001 RAE does not have any bearing on research training programmes in Education, but have a positive relationship in Chemistry. (Table 7) Similarly, it is only in Education that senior and Far East Asian students are less satisfied with research training programmes than junior and non-Far East Asian students.

Table 7: Multiple Regression for Predicting Research Training Programmes in Education and in Chemistry with 2001 RAE

Research Training Programmes	Education			Chemistry		
	Beta	T	Sig.	Beta	T	Sig.
2001 RAE	.08	1.47	.14	.15	2.43	.02
Year of study	-.12	-2.22	.03	-.09	-1.48	.14
Far East Asian students*	-.17	-3.04	.00	.01	.09	.93
Gender (Female:1;Male: 0)	-.06	-1.12	.26	-.08	-1.29	.20
Model Summary: R Square (Adjusted R Square)	.05 (.05)			.04 (.02)		

(* Far East Asian students: 1; Others: 0)

The striking fact in Table 8 is the disciplinary variations in research facilities. First, the 2001 RAE has a negative relationship with research facilities in Education, but it has a positive relationship in Chemistry. Second, it is only in Education that research facilities are less favourably perceived by Far East Asian students than other students.

Table 8: Multiple Regression for Predicting Research Facilities in Education and in Chemistry with 2001 RAE

Research Facilities	Education			Chemistry		
	Beta	T	Sig.	Beta	T	Sig.
2001 RAE	-.19	-3.42	.00	.23	5.44	.00
Far East Asian students*	-.18	-3.19	.00	.01	.26	.80
Year of study	-.04	-.81	.42	-.02	-.40	.69
Gender (Female:1;Male: 0)	-.02	-.28	.78	-.02	-.50	.62
Model Summary: R Square (Adjusted R Square)	.08 (.07)			.05 (.04)		

(* Far East Asian students: 1; Others: 0)

Doctoral education in Education and Chemistry: a brief summary of findings

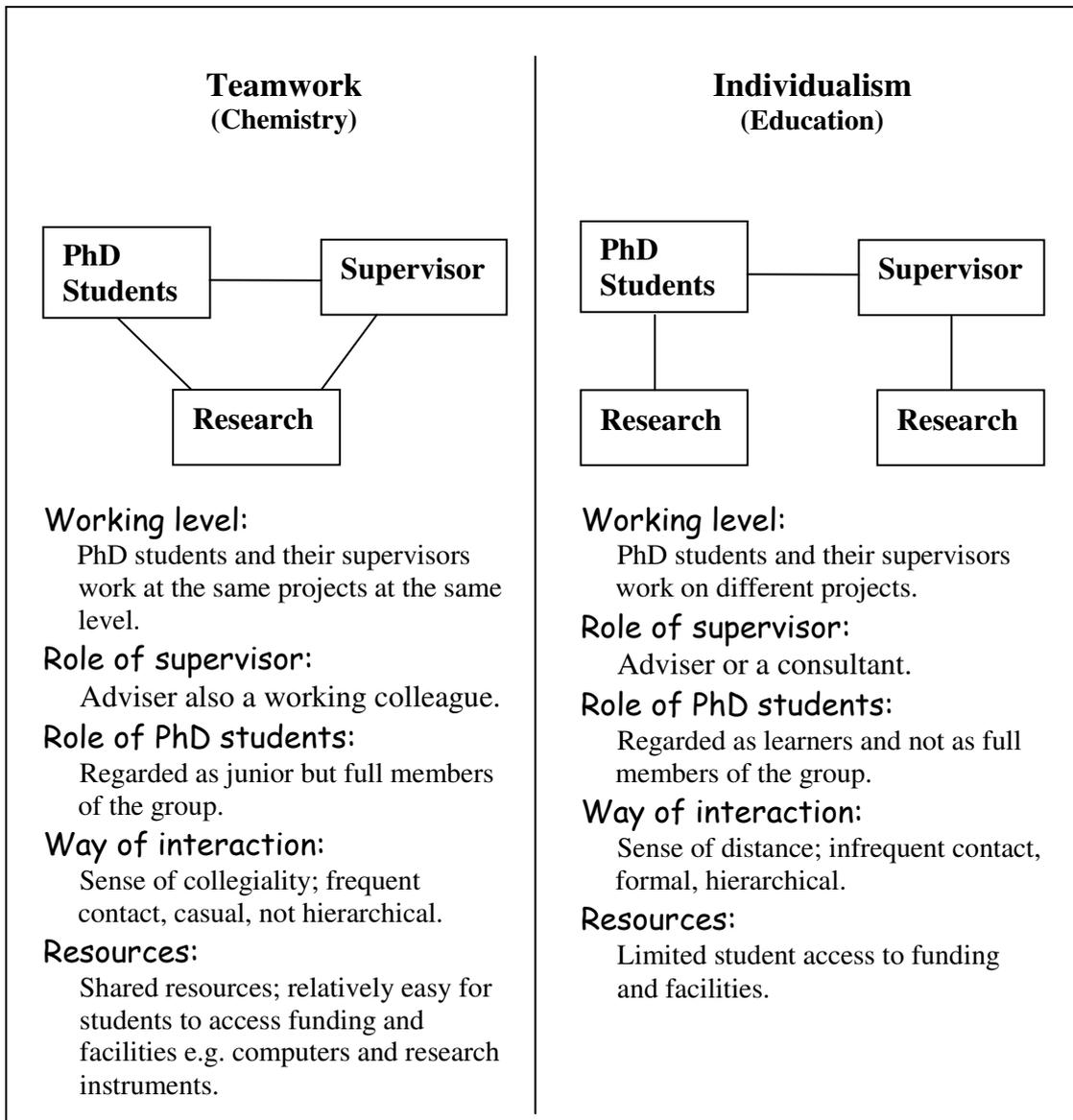
According to Chiang (2003), doctoral education in Chemistry in general is seen to be more appreciated than in Education, especially regarding the three aspects of research environment for doctoral students: academic culture of facilitation, intercultural facilitation of research and research facilities. Supervision is also perceived to be more satisfactory in Chemistry than in Education especially in aspects of supervisor's knowledge, supervisor's research workload, supervisor's student-load and supervisor's helpfulness in finding funding.

A Theoretical Framework of Teamwork and Individualist Research Training Structures in Ideal and Degenerative Types

The empirical findings on the whole show a neutral relationship between staff research and teaching in doctoral education especially in supervision, which applies to both subjects even though it is also showed that Chemistry departments are generally more appreciated than Education departments (ibid.). The question now is: why there is no strong evidence of a relationship between staff research and teaching in doctoral education and why the similar result is found in both subjects while a difference of students' learning experiences between the two subjects is indicated in the empirical data (ibid.)?

A theoretical framework of the Teamwork and Individualist research training structures illustrated by both the interview data and literature is developed for discussion (ibid.). It is presented in Figure 1. In brief, it was reasoned that because "the Teamwork research training structure in Chemistry, leading to sharing, co-operation, collegiality, informality, a sense of worth and friendliness" (ibid.: 22) that Chemistry departments are more appreciated than Education departments on most counts in research environment for doctoral students and in supervision.

Figure 1: Comparison between Research Training Structures of Teamwork and Individualism

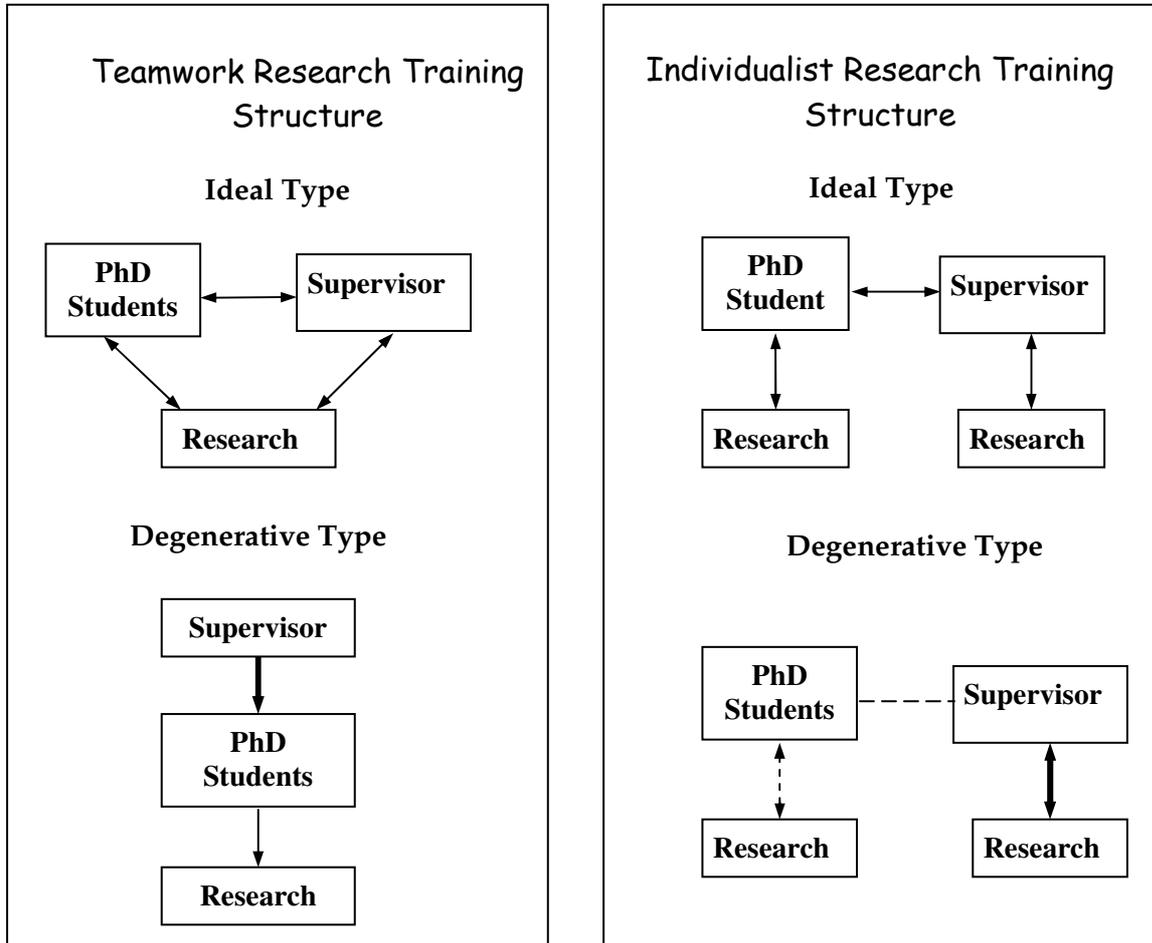


(source: Chiang, 2003:19)

Based on the framework of the Teamwork and Individualist research training structures developed in Chiang (2003), and from the interview data and literature, this paper further reasons that what happens in the research training structures is not fixed. Both research training structures have their ‘Ideal’ type and ‘Degenerative’ type. By ‘Ideal type’, I mean that all the given conditions are working well. This suggests that both human and physical resources are adequate and well distributed; competition is constructive and no pressure on staff to publish. By ‘Degenerative type’, I mean that

the ideal conditions are not met. The two research training structures in these two types are presented in Figure 2.

Figure 2: Relationships of Research Training Structures in Two Types



(source: compiled by the author from the materials discussed in the text.)

When the given conditions are working well, the Ideal type of the Teamwork research training structure functions in an environment where the co-operation between researchers is promoted at all levels. This cultivates doctoral students to be co-operative researchers with good interpersonal skills. On the other hand, in the Ideal type of the Individualist research training structure, PhD students are able to call upon supervisors and other researchers whenever it is necessary. This encourages the sense of autonomy and liberty, leading to the education of independent thinkers.

The Degenerative type means that the above conditions are not met. This may happen when either human or physical resources are inadequate and especially when the competition is destructively intense, such as the great pressure for publication. There may be a shortage of staff and resources, leading to highly competitive application for funding, severe competition for reputation and heavy pressure of publishing for academic staff.

Under those extremely pressurised conditions, the Teamwork research structure can result in a more self-centred approach by supervisors taking over the research projects carried out by doctoral students. For example, students become “hands of their supervisors” to do “dirty jobs” in the laboratory. (F, H) In one of the interview sites, students are asked to sign a contract that “they [students] can only have one Sunday free in a month and they do not even have bank holidays.” (F) The highly competitive situation for “team’s productivity” is likely to have detrimental effect on doctoral students. (Becher et al., 1994) As a consequence, either the research projects are likely to be taken over by the supervisors or a large number of PhD students are recruited to do “dirty jobs” for staff. In the latter case, it was regarded as “a strategy for maintaining the team leader’s own rate of publication ... in a context where most of his time is spent essentially on team management.” (quoted in Becher et al., *ibid.*: 72) This strategy may pressurise students to “prolong the experimental stages of their work or neglect of them on the part of their supervisor.” (*ibid.*) Doctoral students then are treated as cheap labour. (Brown & Atkins, 1988: 117) For example, informant H who has a Graduate teaching studentship states, “so the only benefit for the college is that they get a member of staff for four years who does all the bad bits of teaching and you only have to pay them nine thousand pounds a year. Whereas if you get a junior lecturer, you have to pay much more. In that sense, yes, I think it is cheap labour. ... Yes, PhD students are very cheap, very good value for money for the research. If you want to research for academics, it’s very cheap to have a PhD student and not very cheap to have a postdoc.” Both doctoral students’ efforts and creativity are prone to be exploited by the supervisor. The work of the individual student is sacrificed to the research group and the department as a whole.

In contrast to the cultivation of constructive team co-operation in students in the Ideal type of the Teamwork research training structure, students in the Degenerative type of departments may suffer from academic procrastination or dilatoriness (Boice, 1996: 31; Ferrari et al., 1995: 80-81) and self-handicapping syndrome (Boice, op. cit.; Ferrari et al., op. cit.). These can be caused by imposing instructions from the supervisors, which perhaps leads to subordinating behaviour and task aversiveness for students (Muszynski & Akamatsu, 1991 in Johnson et al., 2000: 270). Although laboratory sciences students have the lowest rate of attrition compared to students in the social sciences and humanities (Bair & Haworth, 1999: 10), academic procrastination and self-handicapping syndrome can increase the time to completion of the degree and also develop students' impaired self-understanding (Boice, op. cit.: 32). As a result, students may lack academic confidence in their research area.

In the Individualist research training structure, the poor and highly pressurised conditions can distract either academics from their supervision of students or the departments to provide good research education for students. According to Becher (1987a: 286; 1989: 86), the pressure to publish in soft-applied subjects such as Education is generally less than hard-pure subjects such as Chemistry. Nevertheless, the severe competition caused by the RAE may have brought more pressure to bear on academics, which in turn has degenerative effect on the doctoral education. Under those conditions, academics focus more on their own research projects (Becher et al., 1994); doctoral students are likely to suffer from the neglect both from the supervisors and the department. For example, B finds that supervisors are seen to be passive and "un-interested" in relation to students' research. D reasons that the neglect of Education doctoral students' research at the department level is because doctoral students' research is not considered in the RAE evaluation. "I think until you can contribute to that RAE score, you are not important. You may well attend the conference, you may even write the paper, but it has not got the same ... it doesn't count for anything. Until the moment you can be included into their score, then it has some relevance." Education students' research may not be interfered with by the

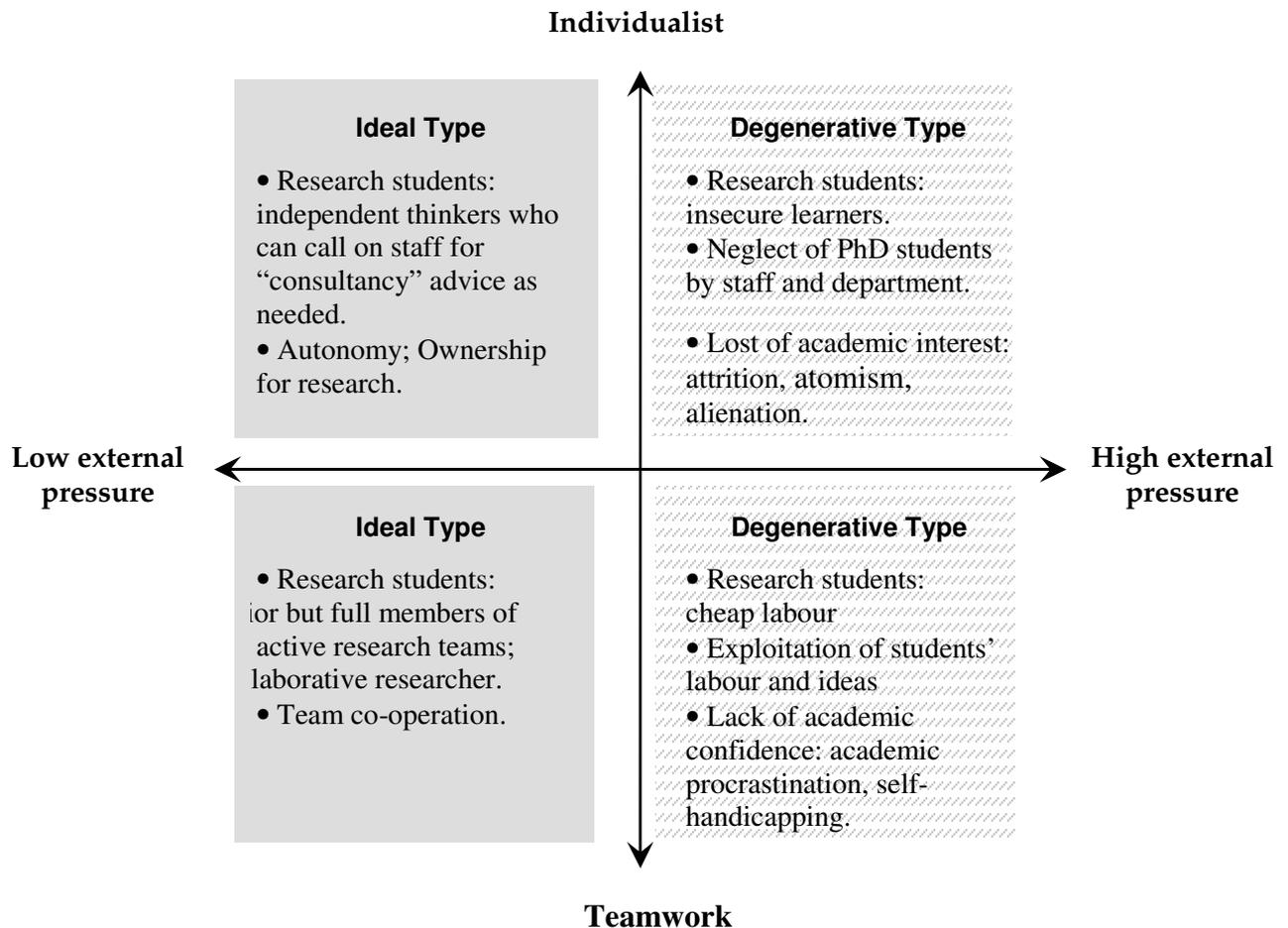
supervisors' as those in the Teamwork research structure are. Instead, they are prone to feel they are being left to sink or swim.

In comparison with the encouragement of autonomy and ownership for research in students in the Ideal type of the Individualist research training structure, students in the Degenerative type of departments are prone to suffer from attrition (Bair & Haworth, *op. cit.*). The difficult accessibility of supervisors resulting in lack of guidance in the Degenerative type of departments, and the individualistic nature of student research in general can bring about students' feelings of isolation (Lovitts, 1996), deprivation and alienation (Golde, 1994). It can also cause "atomism" and "pluralistic ignorance" among students (Lovitts, *op. cit.*). As a consequence, it not only can result in academic procrastination leading to serious delay and high attrition. It also can make students lose their academic interests in their research areas, which can lead to giving up a research career and finding jobs outside the academy (Kendall, 2002: 133; Harman, 2002: 184-186) even if they finally complete their PhD.

Becher et al. (1994, *op. cit.*) point out that unsatisfactory experiences of postgraduate students are likely to exist in most prestigious institutions or in the context of intensive competition among academics. The high pressure conditions in Degenerative types of both research training structures can also jeopardise the wide range of different roles which should be undertaken by the supervisor (Bennett & Knibbs, 1986; Phillips & Pugh, 1987; Brown & Atkins, 1988).

The combination of these two types and two research structures are presented in a two dimensional frame. Figure 3 presents the corresponding features of the four combinations.

Figure 3: Features of the Research Training Structures in Two Types



(source: compiled by the author from the materials discussed in the text.)

This theoretical framework horizontally differentiates the Ideal and Degenerative types by the degree of external pressure. Vertically it distinguishes the Individualist and Teamwork structures.

Interpretation of Findings

To begin with the framework horizontally, it helps throw some light on the major finding: why is there little evidence of a strong and significant relationship between staff research and effectiveness of doctoral education, especially concerning the three aspects of supervision, which applies to both subjects

The main reason for the above findings can be elucidated by the Ideal and Degenerative types. The high pressure and fierce competition for resources can make the research structures slide into the Degenerative types. In the current situation in the UK universities, Research Assessment Exercises pose immense pressure on staff in departments in almost every aspect. The original idea of such exercise was to make people “become aware that there was some rationale in UGC funding; before then the UGC funding was a total black box” (Kogan & Hanney, 2000: 101), but “the consequences of the RAE have become progressively more severe.” (ibid.: 98) It is likely that such competition is even more severe among departments with higher RAE scores than it is among those with lower RAE scores. This can be because it is more difficult to be distinguished among institutions with higher RAE scores. Therefore, in order to maintain the research reputation, departments with higher RAE scores are under more pressure to compete with their opponents which also seek higher RAE scores. For example, in eight research-intensive universities in Australia, Harman found that “the [PhD] student satisfaction levels are disturbingly low” (2002: 188).

Under these circumstances, Chemistry departments with high RAE scores are likely to be at the very right end of the horizontal axis -- becoming a serious case of the Degenerative type in the Teamwork research training structure, while Chemistry departments with low RAE scores are more likely to be relatively nearer to the Ideal type. This means, Chemistry students in the departments with high RAE scores are prone to be negatively exploited.

It can be because departments with high RAE scores slide further towards the far right end of the Degenerative type so that Chemistry doctoral education, especially in all three aspects of supervision and in intercultural facilitation of research in research environment for doctoral students, do not become better in departments with higher RAE ranking. It is perhaps because the Degenerative type of the Teamwork structure in the departments with higher RAE scores makes academic staff and students difficult to relate to each other so that academic culture of social interaction in Chemistry is seen to be less satisfactory. Similarly, it is due to the same highly

pressurised conditions in the Chemistry departments with higher RAE scores that supervisors become less accessible for students. The reason for a slight positive relationship between the RAE and research training programmes can be because formalised research training programmes are a new practice in Chemistry doctoral education. When the questionnaire survey was conducted, less than half (48.3%) of Chemistry departments have some form of research training programmes. The departments which have formalised research training programmes tend to be concentrated in those with high RAE scores.

In a similar vein, the competition among Education departments with high RAE scores is likely to be much fiercer than it is among those with low RAE scores. The pressure of publication on each member of staff in the Education departments with high RAE scores is greater than in those with low RAE scores. For this reason, Education departments with high RAE scores are likely to be at the right end of the horizontal axis where the serious cases of the Degenerative type of the Individualist research training structure are located. Education PhD students in those departments, therefore, are likely to experience neglect from both the supervisor and the department. They feel left alone and struggle on their own.

As a consequence, it could be because of the Degenerative type of the Individualist research training structure in the Education departments with high RAE scores that staff are too busy with their own research to be available for doctoral students. This explains why supervisor's accessibility is not perceived to be better in Education departments with higher RAE scores. The highly competitive conditions can make Education departments with higher RAE scores too preoccupied with promoting staff research to merit attention to doctoral students' research and education, that academic culture of social interaction and research training programmes are not perceived to be better. The same stressful conditions in Education departments with higher RAE scores may further frustrate the communication between supervisors and students, that students are less made aware of supervisor's research. This explains why there is no relationship between the RAE scores and relevance of supervisor's research to

student's research. Next, due to the Degenerative type of the Individualist research training, Education departments with higher RAE scores are so concerned with staff research and publication that doctoral education could be marginalized. As a result, those departments may neglect of PhD students, especially those from foreign countries, so that intercultural facilitation of research is tentatively suggested to be slightly less satisfactory in the departments with higher RAE scores. In addition, for the same reason of the Degenerative type, academic staff in the departments with high RAE scores could be unavailable for students. Therefore, supervisor's facilitation of learning is tentatively implied to be slightly less satisfactory in the department with higher RAE scores.

On the other hand, the vertical dimension of the theoretical framework helps explain not only the disciplinary variations in some of the relationships between staff research and different aspects of doctoral education but also the disciplinary differences in effectiveness of doctoral education. (To avoid repetition, please see Chiang, 2003)

The resulting consequences are that firstly, the Teamwork structure leads to the sharing of resources in Chemistry such that research facilities for students are perceived to be better in the departments with higher RAE scores. The lack of this teamwork dynamics in Education in general can lead to the absence of resource shared between staff and students. The lack of sharing resources plus the Degenerative type found in the departments with high RAE scores further explain why research facilities are perceived to be less satisfactory in Education departments with higher RAE scores. Next, it is recognised in the Teamwork research training structure that in order to have the utmost result of contribution and publication in a high paradigm area (Lodahl & Gordon, 1972), supervisors and students need to be co-operative (Becher, 1984, 1987a, 1987b, 1989; Becher & Trowler, 2001) and their research need to be closely linked. It could be because of this reason that supervisor's research is more related to that of student's in Chemistry than in Education. It is perhaps due to the Teamwork research training structure in Chemistry, leading to sharing, co-operation, collegiality, informality, sense of worth and friendliness, that

Chemistry departments are more appreciated than Education departments especially pertaining to most aspects of research environment for doctoral students.

With regard to the reason why the response rate of Education students (81.3%) is much higher than Chemistry students (41.3%), it can be because Education students working in an Individualist research structure are more likely to feel less heard and feel less appreciated than Chemistry students (Moser & Kalton, 1975: 262; Aldridge & Levine, 2001: 18). Therefore, there are more responses from Education than Chemistry students when Education students have an opportunity to address their opinions and feel valued.

Reflections and Conclusions

Following upon this discussion and the findings in the research, I may now put forward some ideas for future research and proposals for action. To begin with, the findings of this research pertaining to the relationship between research and teaching reveal a somewhat different picture from previous studies, especially those which focus on staff perspective and those which are only based on staff self-reported rating of either their own teaching or the link between research and teaching. The result shows that there is a discrepancy between staff perceptions of their own teaching and students' experience of teaching. It also challenges those studies which do not measure research and teaching separately but are only based on staff's perceptions of the link between research and teaching. One of the important lessons from this research is that the findings about the relationship between research and teaching can be partial if only staff perceptions are taken into account. Hence, it is crucial to investigate the relationship between research and teaching from a student's perspective. Due to this, there exists a strong need for research that seeks to gain directly from doctoral students about their thoughts, experiences, feelings, behaviours and subsequent performance inside or outside their discipline regarding measurement of doctoral teaching (such as supervision and research training) and the link between research and doctoral education.

Furthermore, more than 40% of full-time doctoral students are from foreign countries according to HESA (2002) and the findings show that foreign students in general are less satisfied with the doctoral education than home students. As a consequence of this, more research would be needed to look at how the doctoral education corresponds to the cultural variations of students.

The discovery of lack of a relationship between staff research and teaching in doctoral education in general does not mean that staff research and teaching have the same status. In most cases, research (or the scholarship of research) is more valued in the academic community than teaching (or the scholarship of teaching). Consequently, scholarship of teaching will still need to be promoted if good quality doctoral education is to be delivered. At doctoral level, this includes the recognition of doctoral supervision. I suggest that doctoral education should be part of teaching assessments. Both individual supervisors and departments who are committed to good supervision should be rewarded.

In the light of the evidence, it can be claimed that the current mechanism of research assessment in UK universities, the RAE, provides few benefits to doctoral education. Further investigation is needed, therefore, for finding a better way of evaluation of research and research training in order to promote both staff research and teaching in doctoral education.

Further research will be called to explore questions such as, would research training in Education improve if it involves doctoral students in staff research projects as it does in Chemistry? How to facilitate doctoral study in Education to learn from the spirit of teamwork in Chemistry to improve the supervisor-student interaction and to solve the isolation experienced by doctoral students and marginalisation of doctoral education in Education? Would doctoral study in Chemistry improve if it learns from the spirit of individualism in Education to avoid interfering of student's ideas in doing research or treating students as cheap labour as found in the Degenerative type of the Teamwork structure? The findings imply not only that it is worthwhile avoiding the

different degenerative effects caused by high external pressures such as the RAEs in doctoral education in the two subjects, but also that Education departments should see their own role as one which facilitates recognition (and some satisfaction) of doctoral students' needs.

All these issues lead to further and deeper questions concerning the nature of doctoral education. What is the purpose of doctoral education? What is the role played by doctoral education in higher education? Does the current doctoral education cultivate the kind of doctoral students that it intends to? Is doctoral education only concerned with research training? What can the current doctoral education do to prepare their students for their future? If research is not related to teaching, does doctoral education need to provide teaching training for doctoral students to prepare them for an academic career in universities? What is the role of research training in doctoral education in the Individualist and Teamwork structures?

This research shed some light on the relationship between staff research and teaching at doctoral level paying special attention to disciplinary differences. It also highlights the need to further understand the complexity of factors underlying doctoral education. Students' experiences and their suggestions need to be important components of any such research.

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