REFLECTING ON MULTI-, INTER- AND TRANS-DISCIPLINARY (MIT) RESEARCH AT THE CENTRAL UNIVERSITY OF TECHNOLOGY, FREE STATE (CUT)

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Abstract

In their research as well as their teaching, universities of technology (UoTs) expect to be infused by the application of technology and to be integrally related to the world of work. At the same time, research at UoTs is characteristically innovatory, in the specific sense of transforming research discoveries into products or services that are user-oriented and commercially viable. Since practical problems and user needs do not respect disciplinary boundaries it follows, firstly, that such research at a UoT will in some sense not respect disciplinary boundaries, i.e. it will have to connect, cross, or integrate traditional disciplines. This paper seeks accordingly conceptually to differentiate the relevant senses of multi-, inter- and trans-disciplinary (MIT) research. It then characterises the fourteen current research programmes at Central University of Technology (CUT) in these regards, comparing the findings from interviews with the programme leaders with the insights of the authors.

Secondly, in that most research at UoTs is also expected to be innovatory, it is demanded of researchers that they also master the skill of researching the feasible applications of findings, developing products, and envisaging commercialisation; and handing the stakeholder relationships that arise in these interactions. The interviews further indicate the extent to which the respective programmes have moved down the MIT road. They also reveal that the challenges that are faced by the programmes are overwhelming generic rather than specifically MIT-related. Some strategic recommendations are extracted from the findings.

Keywords: Research, multidisciplinary research, interdisciplinary research, trans-disciplinary research

1. INTRODUCTION

In South Africa universities of technology (UoTs) were previously known as technikons, a term that is uniquely local. Technikons provided mainly vocational training, using syllabi prescribed by the responsible national government department, and they could initially not award degrees. This became a stumbling block which had to be addressed as the institutions assumed, and were expected to assume, increasingly demanding teaching and research functions (Du Pré, 2009:1).

In 2003, technikons were accordingly re-designed as UoTs, with the aim of dove-tailing theory and practice in providing business and industry with applicable work place skills and innovation-oriented research (Moraka & Hay, 2009:219).

These types of institutions are not new; in fact, they date back as far as seventeen century London. The newly established Royal Society of London already then saw the need for centres that focused on applied knowledge in especially art, mechanical processes, machines, inventions and experiments (Brook, 2000). In Britain, as in South Africa under her colonial influence, the centres evolved – in response to the heightening skill and knowledge demands of industrialisation – through vocational colleges and then polytechnics into UoTs. These were also termed 'universities of applied science' or 'universities of cooperative education' in other countries following a similar trajectory (Teichler, 1999). If one understands by the term technology 'the human arrangement of nature with the help of tools for human purposes' (Du Pré, 2010:9), then UoTs could be described as institutions that profoundly interweave technology with all three of the defining activities of a university: teaching and learning, research, and social engagement.

In addition to being functionally permeated with technology, UoTs have a different focus compared to other types of universities. In the domain of teaching and learning, this focus is to prepare individuals for the world of work: not only business and industry, but also government – famously termed the 'triple helix' of UoT engagement (Etzkowitz & Dzisah, 2007). This interaction has been extended to a 'quad helix', including communities in society, by Mthembu (2009). In the domain of research, this work-related, user-driven emphasis is satisfied by 'innovation', in the very specific sense of the additional practical research required to transform basic discoveries into useable and marketable products (see Jordaan, 2012).

In both domains, teaching and learning or innovatory research, the essential focus is thus on training technological knowledge workers. Such workers are practical, innovative, and creative, searching for answers, where others might think there are none (Steyn & Du Toit, 2009:1). Knowledge workers need to create, acquire, apply, and transmit work-related knowledge, this implies in particular– in our current post-industrial milieu – that they require and continually update a sound operational knowledge of the various forms of Information Communication Technology (ICT) and their rapidly changing manifestations.

2. THE FEATURES OF UNIVERSITIES OF TECHNOLOGY IN THE SOUTH AFRICAN CONTEXT

In detailing the higher education challenges that South Africa faces, a recent publication from the South African Council on Higher Education touches on the position and place of UoTs.

The report, Universities of Technology – Deepening the Debate (CHE, 2010), stresses that higher education faces a diverse demographic profile in terms of the students they teach. This coincides with the so-called massification of higher education, meaning that large proportions of potential students do want to enter higher education, as they view the attainment of a diploma or degree as the critical pathway to bettering their lives (Du Pré, 2009:4).

With the infused technology and distinctive foci identified above, UoTs are committed to offer relevant programmes that acquaint and equip students for the world of work. It is thus imperative that UoTs are closely allied and attentive to business and industry, government, and society, to better comprehend and address their needs (Moraka & Hay, 2009:219). In discharging this mandate, UoTs are seen to have five distinguishing features: 1) excellence in teaching and learning, 2) developing leadership in technology, 3) technology transfer and innovation; 4) partnerships with business and industry and internalisation; and 5) an emphasis on applied (we would say innovation-oriented) research (Du Pré, 2010:14). Our main emphasis in this text will be on (5), innovatory research, and in particular on the way the abovementioned 'triple helix' (or indeed 'quad helix') engagement of a UoT ensures that such research is overwhelmingly MIT. However, we first touch on the other four features to the extent that they are relevant to a prospective MIT perspective.

2.1 Excellence in Teaching and Learning

The ways in which students are taught in higher education institutions have undergone radical transformation. The emergence of an array of different teaching and learning methods, combined with a mix of different media, like e-learning, has revolutionised teaching and learning. In UoTs in particular this extends to work-integrated learning (WIL), involving a combination of theoretical and work-directed learning, where students work in business and industry, government or civil society as an important and distinctive part of the credits for a qualification.

Specialist practitioners of WIL differentiate work-directed theoretical learning, problem-based learning, project-based learning and workplace learning. However, these have in common that they are aimed at providing relevant practical exposure to students in the actual workplace. This is a defining difference compared to 'classical universities' that focus more on highly academic programmes.

The reverse impact of WIL on the campus academic offerings is that they also take a practical and problem-oriented hue. And since real-world problems rarely respect disciplinary boundaries – think of health or environmental management, or robotics, or graphic design – the on-campus offerings tend towards MIT formulations. At the same time, it is imperative that students receive skills and training that adhere to acceptable standards, both nationally and internationally.

This training at UoTs has been described as “T-shaped” (Volbrecht, 2010), namely disciplinary depth as well as MIT breadth. This calls for effective and imaginative leadership of higher education institutions, to ensure that their organisational entities are sufficiently flexible and interactive for teaching and learning to meet the MIT needs of 'triple helix' users.

2.2 Developing leadership in technology

Given the infusion of technology into the very nature of a UoT, in the way it conducts both teaching and learning and innovatory research, it will develop and apply practical technological competencies to deal with real-world problems (Du Pré, 2010:21). In other words, technology will feature large in both what students learn as well as how they learn; and likewise in what are researched as well as how. A narrow focus to problem solving is not an option, and both students and researchers need to be equipped accordingly. For this to happen leadership in technology needs to be developed – ideally from academics who are savvy in business (and other 'triple/quad helix') applications, as well as business people with academic nous – i.e. entrepreneurial academics as well as academic entrepreneurs, supported by flexible cross-over institutional arrangements (Mthembu, 2009).

2.3 Technology transfer and innovation

The knowledge created through technology application should be transformed into new products, processes and services. The ultimate aim of innovation and technology transfer is to benefit the various stakeholders. The commercialisation of knowledge that is involved can in turn stimulate entrepreneurship and small business development (Du Pré, 2010:24). The sequence of steps that is involved for this to occur in practice is quite demanding, as outlined by Jordaan (2012).

2.4 Partnerships with industry and internationalisation

Jordaan (2012) also deals with the partnerships, joint ventures and other modes of cooperation that are a key feature of innovation by UoTs. The highly applied knowledge and insight gained from these interactions should continuously inform teaching and learning and research within the UoT context. A visible example of this is the phenomenal success of Silicon Valley, where extensive links were created in conjunction with four major universities (Du Pré, 2010:26). Other examples include technical universities specifically meeting the full spectrum of needs required by massive multinationals, such as the institutions associated with Boeing in the US and Nestle in Switzerland. Conversely, and increasingly commonly, universities – not only UoTs – develop “science parks” where small businesses are “spun off” from research centres and incubated. South African examples, in the “research triangle” of Western Cape universities, have been examined in a very recent comparative study by Cooper (2011).

A notably feature of these interactions is benchmarking with similar organisations around the world, for the UoTs seeking to remain relevant and reputable internationally.

2.5 Applied Research

The foregoing makes clear that research in UoTs will be technologically infused, innovatory, and partnership-driven. It follows that it will be predominantly applied (Du Pré, 2009:37). Applied research deals with finding solutions to real-world problems which are encountered by business, industry and society. Such real-world problems are seldom contained within the confines of a single discipline, but are almost always complex and cutting across a range of disciplines (Du Pré, 2009:37). It follows that UoT research usually involves an MIT approach – to be elaborated below – and requires inputs from various disciplines and programmes (Du Pré, 2010:19).

This implies a distinctive research culture; which in turns requires specific strategies oriented to supporting junior and senior researchers alike not only with their research per se, but with the relationship building, contracting, and business-planning associated with innovation, i.e. the extra knowledge and extra steps to transform a discovery into a product and a product into a viable commercial success.

3. LINKING UOT RESEARCH WITH MULTI-, INTER-AND TRANS-DISCIPLINARY (MIT) APPROACHES

We have indicated above how UoT research is not only highly applied, in aiming to solve 'triple/quad helix' user problems, but also innovatory, in the specific sense of seeking the additional process move from knowledge findings to commercially viable products. As a result there are two levels of complexity compared to curiosity-driven research in 'classical' universities. It is for these reasons that MIT research approaches are found to be valuable in stimulating the necessary research collaborations between faculties or programmes. It is accordingly useful to try and distinguish between them.

At a conceptual level, the characterisation of the boundaries between MIT is contested – as is, indeed, the ownership of the key term “trans-disciplinary”. Mittelstrass (2000) recalls introducing it in 1986. In his view inter-disciplinarity arises with “certain problems that escape the confines of a single discipline”, and removes “disciplinary impasses where these block the ... corresponding responses of research”. However, this only involves “concrete cooperation for some definite period”, whereas “trans-disciplinarily means that such cooperation results in a lasting and systematic order that alters the disciplinary order itself”.

Unfortunately, Mittelstrass does not attend to multi-disciplinarily, and his characterisation could as well be read as distinguishing multi- from inter-disciplinarily – e.g. biology and chemistry yielding the discipline of biochemistry, which gained huge impetus from the identification of DNA.

The physicist Basarab Nicolescu (2005:1) more correctly attributes the origin of the term "trans-disciplinarily" to Piaget, who already in 1970 hoped

> *"to see succeeding to the stage of interdisciplinary relations a superior stage, which should be "trans-disciplinary", i.e. which will not be limited to recognize the interactions and or reciprocities between the specialized researches, but which will locate these links inside a total system without stable boundaries between the disciplines".*

In this vein Nicolescu (2005:1) offers a distinction that is explicitly trichotomous. Multi-disciplinarily incorporates "the perspectives of several disciplines", but "always in the exclusive service of the home discipline". Inter-disciplinarity "concerns the transfer of methods from one discipline to another". It too "overflows the disciplines, but its goal still remains within the framework of disciplinary research". Whereas trans-disciplinarity "concerns that which is at once between the disciplines, across the different disciplines, and beyond all discipline."

Nicolescu unpacks this tantalising conception from various angles: e.g., trans-disciplinarity thrives in the interpenetration of different levels of explanatory reality, as are well-accepted in the social sciences between individuals, communities, nations and humankind; and grapples with seemingly contradictory dualities as are found, for example, in quantum mechanics.

More immediately relevant to our purposes is the sympathy Nicolescu's trans-disciplinarity feels for the interplay between object and subject, observer and observed. This is central to the take-up of trans-disciplinarity by Gibbons, Limoges, Nowotny, Schwartzman, Scott & Trow, (1999), for whom trans-disciplinarity is a key feature of Type II knowledge production, as opposed to the older Type I disciplinary research. As Van Manen (2001:850) puts it, "the new mode of knowledge production transcends the disciplinary theories and paradigms from which it is in part derived." It is "more context sensitive, eclectic, transient, and inventive than traditional (or mode 1) interdisciplinary and cross-disciplinary research practices". It is often concerned with applications of technological knowledge to problems in the sectors of the "triple/quad helix" – the province, we have seen, of UoT innovatory research.

Indeed, it has even been argued that part of the validation of trans-disciplinary research therefore inheres in the interaction between producer and user: through researchers thinking beyond the application to the implication of their work, and conversely being influenced by the conceptions and expectations of their users (Nowotny, 2003).

This supplies a novel epistemological foundation for the 'triple/quad helix' commitment of the UoT.

Given this conceptual foundation, we would explicate and illustrate the concepts of MIT research in practice as follows, for use in our subsequent exploration of research programmes at CUT. Multi-disciplinary research refers to the interaction between two or more distinct disciplines in particular research or teaching initiatives or programmes. It may tend to take place at the edges of traditional disciplines, but these nevertheless retain their distinctiveness. It may occur between specialists in the contributing disciplines, or when a researcher has chosen to develop her or his strength in more than one discipline (Boucher, Smyth &Johnstone, 2004:419; Warner, 2009:611). For instance, the new CUT qualification in Health Management will interface between the disciplines of Health Science and Management Science, and corresponding research in the Health Management area will in due course involve collaborations between participating specialist researchers from the two Faculties.

Inter-disciplinary research is evidenced when multi-disciplinary research actually permeates the respective disciplinary boundaries (Boucher, et al., 2004:419), and the collaborations become sustained (and institutionalised, among disciplines, faculties, schools or units). In due course new hybrid fields of endeavour emerge – especially following notable inter-disciplinary advances – that are accorded the status of disciplines in their own right: as in the example of biochemistry we noted above, or of the melding of physics, chemistry and technics in nanotechnology (Mittelstrass, 2000).

Trans-disciplinary research – to recall Piaget's seminal definition earlier – is when several contributing disciplines effectively lose their identities and become effectively submerged in a new research or teaching area, such as Development Studies (which may span Sociology, Political Science, Economics, Anthropology, Demography, History etc.). Environmental Studies is another example; which, as a trans-disciplinary new discipline, is itself soon to be partnered in multi-disciplinary fashion with Management Science, in an Advanced Diploma at CUT. Some would contend that Education, properly conceived, is also an example of trans-disciplinarity across several classical specialities; as is seen when the contributing disciplines' remaining identity may sometimes be evidenced in fragmented disciplinary offerings within the area (Preiser, 2010: 58).

4. METHODOLOGY

With these operationalised distinctions in mind, the strategic research programmes of CUT were analysed for the prevalence and nature of different instances of MIT research, and also to establish factors that might hinder or foster its advancement, given its importance identified at the outset for the

distinctive mandate of a UoT.
The research programme leaders of the fourteen strategic programmes of the CUT were interviewed, and the following two issues were put to them:

- To identify their present MIT-related activities (according to programme leaders).
- To reflect on their planned MIT activities and to indicate the hinderingfactors (according to programme leaders).

In addition, the authors expected to discern different respects and extents in which the programmes activities were already materially addressing innovation, in our specific sense of being involved in the MIT-based development and bringing to market of products or services based on discoveries.

The first enquiry was of mixed success. It turned out that nine of the fourteen research leaders believed that their programmes were engaged in all three activities. This is shown by the tick-marks in Table 1. This might be true, in the intended nature of applied, problem-oriented, user-driven research expected at a UoT, as we considered it in Section 2. But in practice one might expect MIT to be occurring in differing extents, given the varying nature and trajectories of the programmes. The authors' own estimation of which one strand of MIT is predominant in a particular programme is indicated – as a basis for further discussion and enquiry – by the ticks that are ringed inTable 1.

Table 2 seems to confirm, in the column of planned activities, that some programmes are indeed further down the MIT road than others. They also tend to be those that are more evidently innovative, in our specific sense. Thus, whereas the impending agenda of some programmes are still more focussed on publications and conferences, there are three that are already dealing extensively with innovation as defined above: the expansion of an industry-driven automation laboratory, the on-going testing of food samples, and clinical trials.

The right-most column in Table 2, reporting the problems, also proves to be relevant: Much of the most frequently quoted challenges are lack of time and resources, the latter including infrastructure such as laboratories. Lack of postgraduate intake and uneven staff participation or motivation is also mentioned. However, all these are generic challenges to the activity of any typical researcher or research entity, especially at a teaching-intensive establishment. By contrast, there is only one oblique indication that might be thought to arise from the particularly MIT nature of the programmes: “Education is not colleague's main area of expertise”. This is perhaps an encouraging indication – to the extent the programme leaders' remarks are more broadly indicative – of the absence of the rivalries and disparagements that are traditional in disciplinary contexts.

Table 1 Strategic Research Programmes and focus of CUT

Strategic Research Programmes	Research Approaches			
	Research focus	Multi-disciplinary	Inter-disciplinary	Trans-disciplinary
New product development and design	Industrial design, communication and development			(✓)
Evolvable manufacturing, automation and vision systems.			✓	○
Energy Management		✓		(✓)
Water resource management		(✓)	✓	✓
Information and communication technology		✓	(✓)	✓
Applied food safety	Quality of health and living	✓	(✓)	✓
Sustainable farming system		✓	✓	○
Applied health technology		✓	(✓)	✓
Environmental assessment and management		✓	(✓)	✓
Biotechnology		✓	(✓)	✓
Socio-economic development studies	People and skills development	✓	✓	(✓)
Leisure Management		✓	✓	(✓)
Education (medical education, service learning, technical and technological education)		(✓)	✓	✓
Research education				(✓)

Table 2: MIT progress per strategic research programme and hindering factors

Strategic Programme	Progress towards MIT	Hindering factors
New product development and design	Conference in June 2011. Staff visited Germany and Sweden to inspect machines and processes.	Time and funds
Evolvable manufacturing, automation and vision systems.	Expansion of laboratory, include automated reconfigurable assembly system	None
Energy Management	Programme is in the conception phase. No specific activities have been decided upon.	None
Water resource management	Projects – climate change, land use planning and hydrology.	Time constraints Funding
Information and communication technology	Management Information systems (data basis) Agents	Limited research capacity (no PhD in this field).Very large classes.
Applied food safety	Questionnaires and data gathering take place on continuous basis (formal and informal industries) on following issues:Food micro-biology, nutrition, bio-chemistry, molecular biology, food safety risk assessment and food bio-technology	Laboratory space and infrastructure problematic.
Sustainable farming systems	Publications, conferences, industry problem-driven solution, current projects include: pigs, functional efficiency on animals and sustainability of life stock systems	Time constraints Project funds
Applied health technology	Clinical trials, papers, conferences and patents, biological laboratory work.	Money for research, infrastructure (work off campus), dependence on state hospitals.
Environmental assessment and management	Activities to establish the programme, like publications, proposals, delivering papers, etc.	Time constraints Education is not colleague's main area of expertise.
Biotechnology	Main focus area is water quality.	Space for students and laboratories inadequate.
Socio-economic development studies	Activities include the National Entrepreneurial Conference (hosted in 2009 and 2010), post graduate students and papers presented.	Time constraints Not all staff and post graduate students participate in the activities.
Leisure Management	Book chapters, papers, national and international conferences, articles.	None
Education (medical education, service learning, technical and technological education)	Book chapters, papers, national and international conferences, articles.	Lack of participation and negative attitude.
Research education	Workshops on 1) the research process, 2) research ethics and integrity, 3) science writing and 4) post graduate supervision. Publications include tips for post graduate students and the Interim Journal.	Not all staff and post graduate students participate in these activities.

4. OBSERVATIONS AND RECOMMENDATIONS

The following observations arise from our conceptualisations and evidence:

- The obstacles to the furthering of research and innovatory research in particular, as reported by CUT's programme heads are overwhelmingly generic – lack of time, money, infrastructure and recruits – rather than MIT-specific.

- Conversely, aspects of MIT research, individually or in combination, are not unfamiliar to the researchers or research environment at CUT. (The approach of programmes within clusters, indicated in the rectangles in Table 1, was launched in 2005.) Most programmes readily identify with MIT, and only one mentions a challenge to their activities specifically related to MIT in contrast to disciplinary research. The authors would add that in furthering MIT in the research environment, improvements may be sought in the modalities and practicalities by which different faculties or programmes can actually interact with each other on an MIT project – though this was not a complaint of the interviewees, perhaps because the question was phrased in programme-oriented fashion.

- The innovation 'cycle' of converting research through production to commercialisation should be further developed. The concept needs to be promoted at CUT that research at a UoT has two levels. Firstly, there is the level of academic research – where the classical understanding of research prevails, namely that a research problem leads to a solution. Secondly, the solution should now be taken to the level of incubation, prototyping and eventual commercialisation, i.e. innovation. At a UoT both levels are essential.

- The interviews suggest, in the envisaged outputs, that the concept of aligning to strategic innovatory research programmes is not adequately recognised and effectively incentivised in all schools at CUT. It follows that MIT-oriented and innovatory opportunities for cooperation can be better explored, with the corollary of better access to the plentiful grants that exist to foster such activity – especially from government, for university-industry collaborations and for government's own needs.

- The research methodology courses for postgraduates need to be extended to include second level of the innovation cycle mentioned above. Moreover, these skills need to be honed in practice by what one might call postgraduate WIL, participating as 'apprentices' in the innovatory research teams of experienced practitioners.

5. References

Boucher, C., Smyth, A. & Johnstone, M.J. 2004. Creating collaborative spaces: The pleasures and perils of doing multi-disciplinary, multi-partner qualitative research. Journal of Higher Education Policy and Management, 26(3): 419-428.

Brook, D. 2000. Revisiting the idea of a university. In Lategan, L.O.K. (Ed.) The making of a University of Technology. Technikon Free State Studies in Higher Education. No 3. Bloemfontein: Technikon Free State.

Cooper, D, 2011. The University in Development. Pretoria: HSRC Press.

CHE (Council on Higher Education). 2010. Kagisano No 7: Universities of Technology – Deepening the Debate. Pretoria: Council on Higher Education.

Du Prè, R. 2009. The Place and Role of Universities of Technology in South Africa. Durban: Durban University of Technology.

Du Pré, R. 2010. Universities of technology in the context of the South African higher education landscape. In Kagisano No 7:Universities of Technology – Deepening the Debate. Pretoria: Council on Higher Education. pp. 1-41.

Etzkowitz, H. & Dzisah, J. 2007. The triple helix of innovation: Towards a university-leddevelopment strategy for Africa. ATDF Journal, 4(2): 3-10.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P.& Trow, M. 1999. The new production of knowledge: The dynamics of science and research in contemporary societies. London: Sage.

Jordaan, G.D. 2012. A proposal for innovation and technology transfer at the CUT. Interim 11(1): 34-43

Mittelstrass, J. 2000. Trans-disciplinarity – New Structures in Science. Presented at the conference Innovative Structures in Basic Research" at Schloss Ringberg.Available from:http://xserve02.mpiwgberlin.mpg.-de/ringberg/Talks/mittels%20%20CHECKOUT/Mittelstrass.html.Accessed: 1 December 2012.

Moraka, T.S. & Hay, H.R. 2009. The implementation of a capacity development system for academic staff in higher education: The case of the Central University of Technology, Free State. Journal for New Generation Sciences, 7(2): 218-233.

Mthembu, T. 2009. From academic capitalism to strategic partnerships for socio-economic development. Bloemfontein: CUT.

Nicolescu, B. 2005. Trans-disciplinarity – past, present, and future. Paper presented to the Second World Congress on Trans-disciplinarity. Vila Velha, Vitoria, Brazil. Availablefrom:http://cetrans.com.br/novo/textos/-transdisciplinarity-past-present-and-future.pdf. Accessed: 1 December 2012.

Nowotny, H. 2003. Democratising expertise and socially robust knowledge. Science and Public Policy, 30 (3): 151-156.

Preiser, R. 2010. Observing representational practices in art and anthropology – a transdisciplinary approach. The Journal for Transdisciplinary Research in Southern Africa, 6(1): 57-72.

Steyn, P.D. & Du Toit, A.S.A., 2009.Maximizing the value of knowledge workers.South African Journal for Information Management, 11(1): 1-10.

Teichler, U. 1999. Higher education policy and the world of work: changing conditions and challenges. Higher Education Policy, 12(4): 285-312.

Van Manen, M. 2001. Trans-disciplinarity and the new production of knowledge.Qualitative Health Research, 11 (6): 850-852.

Volbrecht, T. 2010. Graduate attributes and work-integrated learning. Presentation to the CUT Conference, Strategic Transformation of Educational Programmes and Structures. Bloemfontein. Available from: www.cut.ac.za. Accessed 1 December 2012.

Warner, J.O. 2009. Multi-disciplinary paediatric research. Paediatric Allergy and Immunology, 20: 611.