

Geography: Research and teaching in nurse education

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Abstract

This paper outlines how geography might be integrated into nurse education. At one level, researching nurse education geographically could add to the current academic understanding of the many transitional places that make educational experiences and influence outcomes. At another level, as part of a nursing curriculum, teaching geographical concepts and issues to students might provide them with unique insights into core subjects. © 2013 Elsevier Ltd. All rights reserved.

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Introduction

Signifying at least the beginnings of a 'spatial turn', a body of nursing research has emerged in recent years that takes a distinct geographical perspective. This work represents the most substantive meeting to date of nursing research and human geography, wide-ranging disciplines that have coexisted for many decades. Mirroring the changing and diverse perspectives of health geography (a sub-discipline of human geography), a great deal of this research conceptualizes and understands places as a powerful social and cultural phenomenon. In this sense, places are thought to be imbued with power relations — exerted and negotiated by individuals — and to both capture and communicate symbolism and identity, that both reflects and effects human behaviour (Kearns and Barnett, 1997; Andrews and Moon, 2005). Indeed, experiences of places are thought to be obtained through *situatedness* (or being socially in place), and result in feelings about the place (or a sense-of-place). The underlying and common theoretical assumption of health geography, and these emerging geographical studies of nursing, is that the experience of health care cannot be separated from the places in which it is received (Kearns, 1993; Andrews, 2002). In short, an optimal understanding of place lies somewhere between knowledge of place as an object and the subjectivity of place as experienced (Kearns, 1993).

In addition to these theoretical underpinnings, further theoretical support for this emerging strand of geographical research in nursing is provided by a number of focused review articles (Liaschenko, 1994; Andrews, 2002; Andrews and Moon, 2005; Carolan et al., 2005). As Andrews (2006) suggests, their arguments are based on an observation that new relationship dynamics are emerging between nurses and patients, which are impacted by changing landscapes of health care. More specifically, newer places for healthcare, such as homes, (Liaschenko, 1994), the constant structural and economic transition of traditional settings, such as hospitals (Liaschenko, 1996) and increasingly physical, narrative, emotional and moral distancing between nurses and their patients (Malone, 2003), all emphasize the contemporary relevance of place in practice (Andrews, 2006). Additionally, it has also been claimed that an important contribution of a new geographical strand of nursing research might be to attempt to rethink the longstanding metaparadigm of nursing environment, that has existed for many decades as a central element in conceptual models of nursing (Thorne et al., 1998; Andrews and Moon, 2005). Specifically, it has

been claimed that A geographical analysis offers a dedicated and revised conceptualization of environment. This includes a spatial emphasis, an understanding that environment is relative to the individual and their position in a caring relationship, and a dedicated disciplinary history on which to draw (Andrews and Moon, 2005).

The research in this new field, although extremely broad in scope, might be categorized under a number of key themes (Table 1). As I suggest elsewhere, researching the geographical features of nursing has signified a significant extension of the traditional empirical geographical approach to studying health professionals (Andrews, 2006).

For the most part, this has been undertaken by health geographers and has been focused on doctors' locational considerations in their employment decision-making and broader distributive features in physician labour supply (Andrews, 2006). Arguably, this limited engagement reflects how medical/health geography does not actually engage substantially with the intricate details of, and debates surrounding, the actual 'doing' of either medicine or health care more broadly. It is here then where nurse geographies have been able to significantly broaden the horizons of existing disciplinary perspectives, more squarely considering concepts in care and linking with professional practice debates.

Although, empirically and theoretically, considerable progress has been made, at the same time, there remains a need to establish a comprehensive and compartmentalized agenda for future geographical research on nursing. To date, research has been empirically broad in scope, but currently studies represent only novel 'snap shots' onto nursing; one-off or rare geographical reconnaissances into substantive fields and traditions of nursing inquiry (Table 1). Arguably, in order to focus empirical research, and facilitate the building of more substantive nodes of geographical inquiry, attention needs to be paid to how various and distinct fields and specialties of nursing may be investigated geographically, and how a geographical lens could contribute to their well-established nursing debates and literatures. Notably, this type of debate has just started to emerge with respect to long-term care and gerontological nursing (Wiles, 2005; Andrews et al., 2005b; Cutchin, 2005), but most other specialties of nursing remain relatively unexplored. With respect to nurse education, one study has very specifically considered the geographical dynamics of clinical placement (Andrews et al., 2006; Brodie et al., 2005), whilst a commentary explores cultural safety in nurse education (Kearns and Dyck, 1996). Arguably, as the starting point of all nursing, nursing education is a particularly important field that demands more sustained attention. Indeed, any emerging disciplinary field — social scientific or otherwise — has to be anchored in, and articulated at, the education level so that generations of new practitioners and scholars will be familiar with it, and some able to apply it.

Table 1 Themes and key papers in an emerging geography of nursing

Theme	Key Papers
Gendered dimensions of medical places	Liaschenko (1997), Halford and Leonard (2003) and Radcliffe (1999)
Intimacy, morality and spatial relationships	Purkis (1996), Liaschenko (1994, 1997, 2003), Peter (2002) and Peter and Liaschenko (2004)
Space and place as defining particular types of nursing care	Roush and Cox (2000), Montgomery (2001), Cheek (2004), Lock and Gibb (2003), Duke and Street (2003, 2005), Cutchin (2005) and Wiles (2005), Gilmour (2006)
The role of cyberspace in nurse–patient relationships	Sandelowski (2002), Andrews and Kitchin (2005) and Barnes and Rudge (2005)
Work and educational environments; recruitment and retention	Andrews et al. (2005a, 2006), Brodie et al. (2005), Buchan et al. (1997) and Buchan and Sochalski (2004)
Community health knowledges and issues	Skelly et al. (2002), Cravey et al. (2001), Gesler et al. (2004) and Hall (1996)
The impact of place on the nature, outcomes and transportation of evidence for nursing practice	Angus et al. (2003), Andrews and Moon (2005) and Hodnett et al. (2005)
Environmental health and practice (an associated field)	Grady et al. (1997), Larsson and Butterfield (2002), Watterson et al. (2005), Severtson et al. (2002) and Sweeney and de Peyster (2005)

In this context then, the remainder of this paper considers nurse education in two ways. Through examining the dynamics between nurse education and place, the first section considers the contributions that researching nurse education geographically could make to nurse education research. This might be described as researching the geographies *of* nurse education. Based on this argument that 'geography matters' to nursing and health-care, the second section provides some specific advice on teaching health geography to nursing students. In particular, assistance is given with regard to its structural integration and a guide is provided to the most relevant literature. This might be described as locating geography *in* nurse education. These are very different, yet complementary, ways of indicating how geography can be integrated in our discipline.

Researching geographies of nurse education

A high proportion of researchers who study nurse education already focus implicitly on places. This is simply due to the fact that, during their education, nurses are taught in a wide-range of academic and clinical settings (hence, where much research is based). Certainly then, whether focusing on clinical placements in hospitals or community settings or teaching in classrooms, researchers of education are perhaps more aware of the role of place on experiences and outcomes, than researchers of other fields of nursing. Nevertheless, a geographical approach moves beyond just locating research with settings to, as suggested, investigate the meanings ascribed to, and social construction of places. This elevates place and gives it more sophisticated and in-depth attention.

The emergence of new sites of nursing, and structural changes in traditional sites, both have implications for training as much as working. Indeed, just as established nurses work in a greater number of - and changing - places, nursing students are educated in a greater number of - and changing - places. During their education, nursing students move through time between places, and learn different lessons from the activities that they undertake and the people that they interacted with. In many respects, these places of education are transitional zones that, for better or for worse, bring students to a new understanding of nursing, the health system and perhaps even of themselves. With a capacity to construct and write the rich dynamics of places, incorporating complex and integrated scales, a geographical approach is well-placed to unpack the spatialities in nurse education. The following are most relevant scales.

From regions to cyberspace

In order to determine what the geographical study of nurse education might look like, an initial question to pose is what settings do students learn in, and what cultural and/or structural features help create their experiences and give them a sense of place? The list is undoubtedly long. In the purely academic sphere, they include lecture theatres of various kinds, venues for seminars and small group discussions, simulation laboratories, places for examination, libraries, online (in cyberspaces), and in campus accommodation and at home. In the clinical sphere, they include hospital wards and community settings that give students a 'slice of practice life', and themselves vary according to clinical specialty, client types, case-loads and management style (Andrews et al., 2005a). Arguing for a geographical approach, Liaschenko (1996) reminds us that different institutions do different kinds of work, have different values, codes and underpinning philosophies. Moreover, they are impacted upon by different regional and local policies and themselves produce their own internal policies. In any institution, at both the total and sub-unit scales, place is constituted of coexisting occupational sub-cultures that are engaged in multiple coalitions and power struggles (nurses, for example, with patients, families, doctors, administrators) over multiple

issues. For example, these might be associated with occupational boundaries (for example, over prescribing, patient loads, educational responsibility). On an individual level, these factors combine to influence an individual's agency within a particular place (in the educational sphere whether they be a nurse, lecturer, student or patient), their social interaction and experience of place (Andrews, 2006).

As an example, the clinical placement clearly demonstrates the potential of a geographical approach to help 'unpack' educational places. In order to investigate the co-production of education and the clinical placement, a researcher needs to ask what powers, people and responses make the clinical placement? Power may be enacted through institutional policy, rules and regulations and enacted and enforced by directors, managers, mentors and link tutors. In turn, it is then reacted to, and negotiated, by students. Collectively, here then lies the basis for a particular ward culture and particular student contributions and responses to that culture in terms of 'fitting in', 'coping', 'performing' and academic outcomes (see Andrews et al., 2005a). In terms of what to look for and at, a geographical approach might seek to unpack spatial routines, rituals and practices that exist within, and effectively make, these educational places and the regulation, use and meaning of the social spaces used by different groups. This is what economic geographers might call 'performative labour relations' (Andrews and Moon, 2005). An eventual objective of this type of inquiry might be to recommend how the experience of educational places might be improved and made more consistent.

On a slightly different but related note, the changing ways in which we teach clinical subjects to nursing students have raised interesting questions regarding necessity of physical co-presence (physical bodies in physical places). For example, simulation laboratories provide the opportunity to augment clinical experience and prepare students for practice. However, the nature of place is made quite different by the fact that the student is not in the company of a patient. On another level, the increasing use of the internet for teaching online courses and communicating with students on clinical placements changes the nature of the teacher-student relationship. These are new but important issues to which geographical inquiry is particularly suited (Andrews and Kitchin, 2005).

Moving up in scale, neighbourhoods, towns, cities and regions, present a very different set of geographical experiences and issues. The locales listed above, possess a variety of attractive (or unattractive) features, facilitators or obstacles, that may be economic, social or cultural. Each may impact on a potential student's decision to seek, maintain or cease education in a particular locality, and during the immediate post-education period, whether or not to live and work in a particular locality or institution. Indeed, it has been argued that a geographical analysis of these larger scales of place might contribute to a better understanding of nurse education and labour markets (see Andrews et al., 2006; Brodie et al., 2005).

Teaching geography in nurse education

If we accept the argument that health care and place are inextricably linked, it follows that geographical research might provide a useful source of literature for nursing teachers and students. This paper has already reviewed emerging geographical research by nurses (Table 1). However, the broader sub-discipline of health geography needs to be explored. The subjects that are researched by health geographers are extremely varied. One way of categorizing them is to focus on the core conceptual elements of contemporary geography; geometrical space and socially constituted place. Each will be outlined briefly whilst some indications as to some thematic fields of interest, which crosscut, will be added. It is acknowledged however

that because only a small number of key references can be provided, this analysis somewhat glosses over substantive areas of interest for health geography. Nevertheless, it at least provides an initial insight, and some leads, into the general literature.

The distributive features of disease, health and health care

Human geographers have long been concerned the spatial patterns, or geometry, of human existence over large areas (such as counties, regions and cities). Such an approach, associated with the 'quantitative revolution' in human geography emerged during the 1950s and 1960s and peaked soon after. However, its legacy remains to this day, particularly in health geography. Mirroring this, as a sub-group, health geographers have taken two complementary directions in their research. First, they have indicated how the distance to health services impacts upon their accessibility and utilization, and concurrently population health. Second, they have mapped and modeled the spatial infusion of infectious and non-infectious disease, health inequalities and their facilitators (Andrews, 2002). This considerable literature has only a secondary relevance to clinical practice, so is only briefly introduced here (Table 2). However, it does indicate to students of health professions the broader disease and healthcare contexts within which they will work and that will inevitably impact upon their working lives. Moreover, it complements wider health services and epidemiological research that nursing students currently draw upon in their written work, adding a unique spatial dimension.

Table 2 Some classifications of spatial patterning and modeling in health geography

Subject	References
Diseases	Oppong (1998) and Meade and Earickson (2000)
Health inequal/ behavior	Duncan et al. (1993, 1996, 1998)
Services	Hamnett and Mullings (1992) and Smith and Ford (1998)
GISc	Mitchell et al. (2002) and Higgs (2002)

Place, health and health care

As outlined, human and health geographers are increasingly concerned with the relationships between human activity and place. As indicated above, places can vary in form and scale from natural settings to cities, towns, neighborhoods, institutions and even dwellings. A particular subject of substantive research is the impact of locality on health. Specifically whether neighborhood composition (e.g. socio-economic status) or neighborhood context (e.g. local services) impact most on health (Table 3). On a smaller scale, the impact of service settings, as places, on patient experiences has become a major focus. Specifically, workplace cultures and impacts on care and the symbolism of health and health care places are important avenues for inquiry. Mirroring the increasing emphasis on home as a healthcare environment, research has also become concerned with dynamics and consequences of homes. Meanwhile, reflecting a more general emphasis in social scientific inquiry, the body and place has become a focus of research (Parr, 2002). Here, the connections to nursing are clear, largely because nursing occurs within a variety of settings, as suggested, each of which are integral to its form (Table 3).

Table 3 Some common classifications and thematic areas of health geography

Subject	References
Neighborhood/ community	Wakefield and Poland (2005) and Macintyre et al. (2002)
Symbolism, identity	Gesler and Kearns (2002) and Kearns and Barnett (1997, 1999)
Therapeutic qualities	Gesler (1992, 2003) and Smyth (2005)
Home and informal care	Williams (2002), Milligan (2000) and Wiles (2003)
Older people	Moore and Rosenberg (2001) and Harper and Laws (1995)
Mental health	Parr (2000), Philo (1997) and Wolch and Philo (2000)
Women	Moss and Dyck (1996), Dyck (2003) and Pain et al. (2001)
Children	Goodwin and Armstrong-Esther (2004) and Yantzi et al. (2001)
Public health	Brown and Duncan (2000, 2002)
Historical geographies	Craddock (2001) and Barrett (2000b)
The body	Hall (2000) and Dorn and Laws (1994)
Environment	Eyles (1997) and Wakefield et al. (2001)
Primary healthcare	Moon et al. (2002); Moore (1995) and Redfern and Bowling (2000)

Accessing research in health geography

Subdisciplinary textbooks provide useful introductions to health geography, whilst other books — both texts and provocative pieces - are focused on specific fields of conceptual or empirical interest (Table 4). Insofar as journals are concerned, as its name suggests, the multidisciplinary journal *Health and Place* publishes a great deal of research in health geography. Meanwhile, *Social Science and Medicine* has a dedicated health geography editor, is a reliable source of good quality research, and publishes special editions of research presented at the biannual *International Symposium in Medical Geography* (37, 6; 46, 6; 50, 7-8; 55, 1; 60, 12) the next meeting being in Bonn, Germany in July 2007. In terms of broad geography journals, here health geographers have to compete with researchers from other sub-disciplines that may have a limited health focus. Still, articles are occasionally found in a variety of titles (Table 5). Particularly useful round-ups of research are also found in *Progress in Human Geography* (see Jones and Moon, 1991, 1992, 1993; Kearns, 1995, 1996, 1997; Kearns and Moon, 2002; Parr, 2002, 2003, 2004; Smyth, 2005). A great deal of the wider human geography literature with an education focus is concerned with the teaching of geography in Universities (see *Journal of Geography in Higher Education*). Nevertheless, research published here may provide some ideas for the integration of geography into nursing curricula. Other than these venues, research is also scattered amongst various epidemiology, health service, health sciences and health professional journals, including journals dedicated to specific medical specialties, tasks, patient groups or diseases.

Table 4 Academic books in health geography

Broad Introductory Texts	Jones and Moon (1987), Meade and Earickson (2000) and Gatrell, 2002
Specialist empirical or theoretical themes	Joseph and Phillips, 1984; accessibility and utilization of services Gould (1993); the AIDs pandemic Gesler (1991); culture, health and health care Butler and Parr (1999); physical and mental wellbeing and health Williams (1999); therapeutic landscapes Gatrell (1998); geographical information systems Kearns and Gesler (1998); landscape, identity and wellbeing Dyck et al. (2001); women's health Shaw et al. (2002); health and society Gesler and Kearns (2002); culture and health Gesler (2003); healing/therapeutic landscapes Cliff et al. (2004); epidemic diseases Smallman-Raynor (2004); war epidemics Boyle et al. (2003); health inequality Curtis (2004); health inequality Maheswaran and Craglia (2004); geographical information systems/public health Andrews and Phillips (2005); ageing/gerontology Milligan (2001); caring and the voluntary sector Barrett (2000a); disciplinary origins and medicine

Integration

An obvious and practical question remains as to how to incorporate these subjects into a nursing curricula, at both the undergraduate (pre-registration) and post-graduate (post-registration) levels? Here my own experiences are used to indicate some viable and practical approaches. Whilst working in UK nurse education, I did occasionally encounter modules/courses focused by particular social sciences, for example 'Sociology in Nursing'; 'Health Economics in Nursing'. However, with the ever-increasing demand on nursing curricula in terms of clinical and academic content, it is doubtful, even in the most luxurious of scenarios, whether a dedicated and generalized module/course in health geography would be viable. Therefore, a more realistic approach to integrating geography might be to include a dedicated conceptualization of space and place into existing modules/courses and draw on the appropriate geographical literature in doing this. First, two examples are given to how this was achieved this in my own teaching. Second, I consider the integration of geography into a cross-faculty specialist postgraduate training program. These brief case studies

are meant to be thought provoking and, no doubt, readers will have their own ideas how geography might be incorporated into their own teaching.

Table 5 A selection of human geography journals

<i>General Titles</i>
Progress in Human Geography
Annals of the Association of American Geographers
Transactions of the Institute of British Geographers
Applied Geography
Area
The Professional Geographer
GeoJournal
Geoforum
Environment and Planning D: Society and Space
<i>Specialist Titles</i>
Population, Space and Place
Children's Geographies
Economic Geography
ACME
Gender, Place Culture
Journal of Cultural Geography
Social and Cultural Geography
Philosophy and Geography
Rural Geography
Urban Geography
Political Geography
Journal of Geography in Higher Education

Case one: the integration of geography into nursing courses

Example One: *The Management and Delivery of Healthcare — an undergraduate course*. As its title suggests, this pre-registration/undergraduate module introduced students to a wide-range of management issues, supported conceptually by health economics and management literature. However, the introduction of selected geographical studies facilitated an emphasis on the importance of the spatial allocation of resources. At the micro-level, the role of place in nursing management and delivery was a particular focus and, in particular, geographical debates on the political economy of health care and workplace relationships and cultures provided useful insights. The central message was that geography matters to healthcare management from national planning to ward procedures.

Example Two: *Places, Programs and People who Provide Care — a postgraduate course*. This is a current Masters level course, compulsory for the achievement of a specialism in gerontology. It does more than provide lip-service to geography. In fact, many geographical papers are essential reading, complementing more clinically-focused papers. This spatial emphasis informs the course's focus on long-term care, partly because such provision is hosted in a wide-range of settings from hospital and small institutions to homes. The inclusion of geographical literature and concepts is particularly helpful when considering the role of place in older peoples everyday lives, whether this be within caring environments or wider neighbourhood, urban and rural contexts.

Case two: health care, technology and place: a strategic interdisciplinary postgraduate training initiative

Health Care Technology and Place (HCTP) is a current interdisciplinary research and training initiative, based at the University of Toronto and funded by the Canadian Institutes of Health Research. In the context of rapidly expanding technologies and places for healthcare, it seeks to bring together academics and postgraduates from

diverse health professional, scientific, social scientific and humanities backgrounds and provide diverse theoretical and conceptual teaching and training. As HCTPs website says, to create 'humanistically-informed scientists and scientifically-informed humanists' (<http://www.hctp.utoronto.ca/>). As well as funding a range of small research projects and post-doctoral research, HCTP runs a regular seminar series, annual research workshops and team-taught research courses. To date, the latter have included *Health Care and Place: Concepts, Measures and Policies; Technologies, People and Places in the New Health Care; The Body Health Care, Technology and Place, and Technology and Place in Contemporary Health Care Work*. Students taking these courses include nurses at both the Masters and Doctoral levels.

Geographical concepts and literatures are integrated into teaching in a number of ways. First, students are introduced to research which is explicitly geography (undertaken by geographers, published in geography journals) as part of multidisciplinary perspectives. Second, conceptualizations of place by a range of health professional disciplines, sciences, social sciences and humanities are incorporated. These provide alternative ways of approaching and theorizing place. The results of the initiative, so far, have been a greater appreciation of, and expertise in, researching and understanding the concepts of it place, as it relates to healthcare, amongst a diverse population of postgraduate students. Reviews of the program suggest that some of these students have started to apply these concepts and approaches in their own research.

Conclusion

Because the subjects that social sciences engage with, focus on, reflect and impact on, nursing, academic nurses both research them and teach them to students. Whilst acknowledging the small size and relative infancy of the sub-discipline of health geography, traditionally it had not been integrated to the same extent. Nevertheless, things are changing and geographical perspectives are now making modest incursions into nursing literatures. As demonstrated in this paper, as part of focusing research on specific fields or specialties of nursing, there is potential to both study the geography of nurse education, and locate geography in nurse education. These are two complementary directions that are recommended for future development in nursing research.

Some scholars might question the writing of neatly compartmentalized disciplinary trajectories for the academic study and teaching of nursing, particularly in-the-light-of contemporary moves towards inter- or trans-disciplinary research and practice. Still, I would argue that the 'pure' disciplines that inform our work, still matter. Only by understanding disciplines can we aim for truly inter- or trans-disciplinary research. Indeed, all the relevant sub-fields of science and social science need to be identified, explored and alienated with nursing. This paper has provided some, initial indications to, and reflections on, the roles of geography in nurse education. I argue that this area demands further consideration.

References

1. McCollum, B.: University timetabling: Bridging the gap between research and practice. In E Burke, H.R., ed.: PATAT 2006 — Proc. 6th Int. Conf. on the Practice And Theory of Automated Timetabling, Masaryk University (2006) 15 – 35
2. Qu, R., Burke, E., McCollum, B., Merlot, L., Lee, S.: A Survey of Search Methodologies and Automated Approaches for Examination Timetabling. Technical Report NOTTCS-TR-2006-4, School of CSiT, University of Nottingham (2006)
3. Burke, E., Petrovic, S.: Recent research directions in automated timetabling. European Journal of Operational Research **127**(2) (2002) 266–280
4. Schaerf, A.: A survey of automated timetabling. In: 115. Centrum voor Wiskunde en Informatica (CWI), ISSN 0169-118X (1995) 33
5. Lewis, R.: A survey of metaheuristic-based techniques for university timetabling problems. OR Spectrum (2007)
6. Azimi, Z.: Hybrid heuristics for Examination Timetabling problem. Applied Mathematics and Computation **163**(2) (2005) 705–733
7. Azimi, Z.: Comparison of Metaheuristic Algorithms for Examination Timetabling Problem. Applied Mathematics and Computation **16**(1) (2004) 337–354
8. Rossi-Doria, O., Sample, M., Birattari, M., Chiarandini, M., Dorigo, M., Gambardella, L., Knowles, J., Manfrin, M., Mastrolilli, M., Paechter, B., Paquete, L., Stützle, T.: A Comparison of the Performance of Different Metaheuristics on the Timetabling Problem. In: The Practice and Theory of Automated Timetabling IV: Revised Selected Papers from the 4th Int. conf., Gent 2002. Volume 2740 of Lecture Notes in Computer Science., Springer, Berlin, Germany (2003) 329–351
9. Socha, K., Sampels, M., Manfrin, M.: Ant Algorithms for the University Course Timetabling Problem with Regard to the State-of-the-Art. In: Proc. of EvoCOP 2003 – 3rd European Workshop on Evolutionary Computation in Combinatorial Optimization. Volume 2611 of Lecture Notes in Computer Science., Springer Verlag, Berlin, Germany (2003) 334–345
10. Socha, K., Knowles, J., Sampels, M.: A *MAX-MIN* Ant System for the University Timetabling Problem. In Dorigo, M., Di Caro, G., Sampels, M., eds.: Proceedings of ANTS 2002 – From Ant Colonies to Artificial Ants: Third International Workshop on Ant Algorithms. Volume 2463 of Lecture Notes in Computer Science., Springer Verlag, Berlin, Germany (2002) 1–13
11. E.K. Burke, K. Jackson, J.K., Weare, R.: Automated university timetabling: The state of the art. The Computer Journal **40**(9) (1997) 565–571
12. van den Broek, J., Hurkens, C., Woeginger, G.: Timetabling problems at the TU Eindhoven. In: PATAT. (2006) 123–138
13. Cooper, T.B., Kingston, J.H.: The complexity of timetable construction problems. In: Proc. of the 1st Int. Conference on the Practice and Theory of Automated Timetabling (ICPTAT '95). (1995) 511–522
14. Gross, J.L., Yellen, J.: Handbook of Graph Theory. CRC Press (2004)