A move-step analysis of the concluding chapters in computer science PhD theses

Carmen Soler-Monreal
Grupo GECOLER. Dpto. de Lingüística Aplicada. Universitat Politècnica de València (Spain)
csoler@upv.es

Abstract

This paper describes how computer science doctoral writers construct the closing chapters of their PhD theses. The data are drawn from the chapters playing a concluding role of 48 PhD theses defended at the University of Glasgow from 2008 to 2014. The analysis applied a qualitative-quantitative approach. The titles of the concluding chapters of the theses were first examined and also their divisions into sections and sub-sections. Then the chapters were subjected to a move-step analysis: Move 1 (M1) "Revisiting the study"; Move 2 (M2) "Consolidating research space"; Move 3 (M3) "Proposing practical applications and implications", Move 4 (M4) "Recommending future work" and Move 5 (M5) "Recapitulating the study". The results revealed that most of the computer science PhD theses have one final concluding chapter with three main moves: M1, M2 and M4. The most frequent steps are "reviewing the work carried out" and "summarizing the specific work reported in every thesis chapter" in M1, "presenting results and contributions", "answering the initial research questions or hypotheses", and "making claims" in M2, and "acknowledging limitations" and "suggesting further research" in M4. Move-step patterns appear in recurrent cycles throughout the concluding chapters. Several suggestions for pedagogical purposes are provided.

Keywords: genre analysis, academic writing, PhD thesis, computer science, conclusion.

Resumen

Análisis de movimientos y pasos en los capítulos de conclusiones de tesis doctorales en informática

Este artículo describe cómo los autores de tesis doctorales en el área de la informática elaboran los capítulos de conclusión. Los datos proceden de los capítulos finales de 48 tesis doctorales defendidas en la Universidad de Glasgow entre 2008 y 2014. Para el análisis se siguió un enfoque cualitativo y cuantitativo. En una primera etapa, se examinaron los títulos de los capítulos de conclusión de las tesis así como sus divisiones en secciones y subsecciones. Posteriormente, se analizaron los capítulos atendiendo a unidades informativas organizadas en movimientos y pasos: Movimiento 1 (M1) "Revisión del estudio"; Movimiento 2 (M2) "Consolidación del espacio de investigación"; Movimiento 3 (M3) "Propuesta de aplicaciones prácticas e implicaciones", Movimiento 4 (M4) "Recomendaciones para futuras investigaciones" y Movimiento 5 (M5) "Recapitulación del estudio". Los resultados indican que la mayoría de las tesis de este corpus de informática tiene un único capítulo final de conclusiones con tres movimientos principales: M1, M2 y M4. Los pasos más frecuentes consisten en "revisar el trabajo llevado a cabo" y "resumir el trabajo específico desarrollado en cada capítulo de la tesis" en M1, "enunciar los resultados y las contribuciones en respuesta a las hipótesis y preguntas iniciales" y "reivindicar su aportación" en M2, y "reconocer limitaciones de la investigación" y "sugerir investigaciones futuras" en M4. La práctica habitual consiste en utilizar patrones de movimientos y pasos en ciclos recurrentes a lo largo de la conclusión. Se aportan sugerencias con fines pedagógicos.

Palabras clave: análisis de género, escritura académica, tesis doctoral, informática, conclusión.

1. Introduction

More than four decades have elapsed since the first corpus-based genre analyses were carried out. Many studies have focused on the structure of the research article (RA) written in English in order to investigate its rhetorical features. The CARS (Create a Research Space) model proposed by Swales in 1990 to describe the structure of RA introductions has served as a basis for research on the rhetorical organization of other sections of academic written discourse, largely motivated by pedagogical concerns (Holmes, 1997: 321).

Investigation of the final sections of RAs has not usually distinguished between the terms "Discussion" and "Conclusions" (Lindeberg, 1994; Swales & Feak, 1994; Holmes, 1997; Posteguillo, 1999). Many studies have analyzed this discussion/conclusion section of RAs in a variety of disciplines (Peng, 1987; Lindeberg, 1994; Berkenkotter & Huckin, 1995; Lewin & Fine, 1996; Holmes, 1997, 2001; Nwogu, 1997; Posteguillo, 1999; Peacock 2002; Soler-Monreal & Gil-Salom, 2010; Basturkmen, 2012) and sub-disciplines (Kanoksilapatham, 2015). They have proposed models for

RA discussions with various move structures, the commonest moves being related to the statement of results, the deduction, the claim and the recommendation for further research.

However, and although the titles "Discussion" and "Conclusions" could be synonymous in an IMRD four-section RA, analyses of the overall structure of RAs have shown that RAs in some disciplines lack a systematic pattern. In his study of 40 RAs selected from three different academic journals in computer science, Posteguillo (1999) could not identify a structural pattern common to a majority of RAs. He found that some RAs had no clearly recognizable structural model, while others tried to more closely follow well-established models common in other disciplines, or at least to use some of the sections in these patterns (especially introductory and concluding sections). In fact, RAs very often consist of more than four sections and, apart from the Discussion section, a Conclusion(s) and even an Implications section may be found. This led Yang and Allison (2003) to explore the structure of the RA closing sections reporting empirical research in applied linguistics. They used a move-step method of genre analysis based on the CARS model (Swales, 1990). In this model, a move categorizes segments of text in terms of their particular intentions or functions. The steps for a move are the set of rhetorical choices writers use to realize a specific purpose (Yang & Allison, 2003: 370). According to Yang and Allison, the titles of the RA closing sections reflect the most important purpose of the sections. The move characterizing the discussion section is commenting on results, while the key move in a conclusions section is "summarizing the study" and the typical move in the pedagogic implications section is "dealing with pedagogic issues".

Using Yang and Allison's description of moves in the final sections of RAs in applied linguistics as the starting point of their analysis, other researchers developed a model to suit their findings on RAs and masters dissertations. For example, in their study on RAs in information systems as a branch of business and management sciences, Kwan and Chan (2014) noted that some moves were present in both the results and discussion sections although their frequencies of occurrences varied. They established a unified list of move and step categories for both sections (Table 1).

Re-stating the niche (Niche)
Re-stating the territory Re-stating the niche (gaps/problems) Re-stating the hypotheses/objectives of research
Demonstrating methodological rigors (Methods)
Presenting general research procedures Presenting statistical procedures
Reporting results (Results)
Reporting results in general Reporting results in relation to specific hypotheses Reporting results in relation to models
Commenting on results (Comments)
Interpreting results Comparing results against claims reported in the existing literature Accounting for results
Qualifying overall claims of study (Qualification)
Acknowledging limitations Alleviating limitations claims
Extending the existing territory (Extension)
Announcing contributions Recommending further actions

Table 1. Kwan and Chan's (2014) move and step model for results and discussions of RAs in information systems.

Basturkmen (2009) also used Yang and Allison's model for closing RA sections in her study of the "commenting on results" move in the discussion of results sections of RAs and masters dissertations in language teaching. She concluded that the writers of the RAs and dissertations repeated result-comment sequences involving the step of explanation, the main differences between the two genres being that the sequences in the dissertations were lengthier and more detailed. She also found that the dissertation writers drew on the literature for explaining results rather than proposing alternative explanations, as RA writers did. The dissertation writers seemed to perceive themselves as novices in the academic discourse community, which made them adopt an appropriate stance by putting their own claims in the background (Basturkmen, 2009: 248-249).

Apart from research on masters dissertations (Dudley-Evans, 1986; Samraj, 2008; Basturkmen, 2009; Lewkowicz, 2009; Asunción & Querol, 2013), interest in scholarly texts has also been directed towards doctoral theses with the aim of helping students overcome the difficulties they face. There have been studies of the structure of PhD thesis introductions (Bunton, 2002; Carbonell-Olivares, Gil-Salom & Soler-Monreal, 2009; Soler-Monreal, Carbonell-Olivares & Gil-Salom, 2011; Lim, 2014; Lim, Loi & Hashim, 2014; Lim, Loi, Hashim & Liu, 2015); on literature review chapters (Kwan, 2006; Thompson, 2009; Ridley, 2011; Soler-Monreal & Gil-Salom, 2014a; Gil-Salom & Soler-Monreal, 2014b; Soler-Monreal, 2015); on the discussion of results section (Bitchener & Basturkmen, 2006) and on the conclusion chapter (Bunton, 2005; Lewkowicz, 2012). These studies have identified disciplinary and language-specific variations in rhetorical features, offering guidelines to both supervisors and students in the writing of the PhD genre. However, research on the final chapters of a PhD thesis remains limited to date in spite of their important communicative role.

This study examined the rhetorical structure of separate closing chapters of PhD theses in computer science. The analytical focus was on how computer science writers of PhD theses construct their arguments in the concluding chapters as a series of strategies for communicating scientific findings and emphasizing their contribution to the discipline. The study was limited to one discipline, since different disciplines may follow different organizational and communicative strategies (Hyland, 2004: 151). Computer science was chosen because I had already examined other chapters of PhD theses in the field and I wanted to obtain a complete representation of the discipline in the genre. The study focused on one British university so as to investigate the actual practice of doctoral writers in computer science and ensure homogeneity in the instructions and general guidelines available to the thesis writers. As the doctoral research had taken place in an institution located in UK, I assumed the theses met native-speaker standards for English. I also assumed that the computer science thesis supervisors shared the same views on thesis writing, as confirmed by the results of a survey among them for a previous study (Soler-Monreal, 2015).

Closely related to this study is Bunton's (2005) comparative study of 45 PhD conclusion chapters in science and technology, humanities and social sciences disciplines. Bunton distinguished between thesis-oriented and field-oriented conclusions. For thesis-oriented conclusions he proposed two move-step models with some disciplinary variation (see Tables 2 and 3).

Usually present ≥ 50%	Present ≥ 25%
Move 1: Introductory restatement Work carried out	Territory Centrality Gap/niche
Move 2: Consolidation of research space Method Findings/research Claims References to previous research Product(s)	Explanation Uncertainty Significance Limitations Recommendations for future research Practical applications and implications
	Move 3: Practical applications and recommendations Applications or implications Recommendations
Move 4: Future research Recommendations	Previous research Limitations

Table 2. Science and technology thesis-oriented PhD conclusions (Bunton, 2005).

Usually present ≥ 50%	Present ≥ 25%
Move 1: Introductory restatement Purpose, research questions or hypotheses	Gap/niche Method Reference to previous research Preview of chapter
Move 2: Consolidation of research space Method Findings/research Claims References to previous research	Explanation Theory Information Significance Question-raising Limitations Future research
Move 3: Practical applications and recommendations Implications Recommendations	Reference to previous research Claims Caution/warning
	Move 4: Future research Recommendations
	Move 5: Concluding restatement Overall claims/findings

Table 3. Humanities and social sciences thesis-oriented PhD conclusions (Bunton, 2005).

Bunton found that M1 of most of the science and technology PhD theses focused on the work carried out while less than 50% established the territory, centrality and the gap/niche in research. Conversely, the humanities and social sciences PhD theses more often focused on purpose, research questions or hypotheses. He also found that the steps in M2 often occurred in multiple cycles in all the disciplines. In both models, the most frequently used steps in M2 were method, findings/results, claims and references to previous research. The science and technology PhD theses also reported on products and evaluated them. A distinct M3 was usual in the humanities and social sciences conclusions while it was often embedded in M2 or M4 in the science and technology PhD theses. Conversely, M4 was presented as a separate distinct move in the science and technology PhD theses, while it was often embedded in M2 or M3 in the humanities and social sciences conclusions. Disciplinary variation was revealed because the science and technology PhD theses placed greater emphasis on future research and less on practical implications and applications. Moreover, M5 was not used in the science and technology conclusions. Bunton also found that the science and technology chapters tend to be shorter, with fewer sections and cycles than the humanities and social sciences chapters.

Taking Bunton's findings for science and technology thesis-oriented PhD conclusions as a reference, this study attempted to provide a detailed description of how information is organized in the closing chapters of a set of 48 PhD theses in computer science defended at the University of Glasgow to identify the statistically most important moves and steps. I compared data with previously investigated final chapters of dissertations or RA sections in engineering fields so as to detect specific features of the thesis genre in the discipline of computer science.

2. The discipline

Computer engineering emerged as a result of the development of technology in the 1940s. Since then, it has experienced dramatic growth and diversification, doing research in a wide range of domains such as artificial intelligence, software development and application, hardware maintenance and implementation, telecommunications and biomedicine. Computer science is concerned with the development of IT system architecture, computing models and techniques, either to facilitate information communication and knowledge sharing, extend applications or improve existing models. Very often, the contribution to research in the area is presented as a problem/need solving task aiming to provide users with novel or more efficient forms of technology. In some cases, a problem is introduced and an algorithm or approach is proposed as a possible solution or improvement/optimization strategy. In other cases, a new model or system architecture is presented and the results of its implementation are analyzed. Another type of research consists in applying models to new environments. To accommodate to the nature of research in the field, specific textual organizations and structures are expected.

3. The corpus

Forty-eight theses defended between 2008 and 2014 were selected (see Appendix). While the research topics of all the theses were scrutinized to avoid any remarkable deviation from empirical research, the length, gender and nationality of the authors were not controlled in the selection. The theses are examples of successful doctoral texts having all met the criteria set by the University of Glasgow for the examination of doctoral work in the Computing Department, which provides a common link between the theses and also warrants a quality level for all of them.

The number of chapters in the theses varies from 6 to 12 different chapters, divided into sections and sub-sections. Five theses have traditional IMRD simple patterns and one thesis is a compilation of RAs. But the predominant thesis structures are the traditional complex and topic-based types. Accordingly, traditional complex structures present an Introduction, a Literature Review, an optional General Methods chapter, different case studies under the IMRD format, a Discussion and a Conclusions chapter. Topic-based theses follow the structure proposed by Paltridge (2002), consisting of Introduction, Literature Review (optional), Theoretical Framework (optional), Method, Topic 1: Analysis-Discussion, Topic 2: Analysis-Discussion…Conclusion. The total number of pages under analysis amounts to 351 pages (mean 7.31; SD: 3.95), which represents 4.45% of the total pages of the corpus (excluding abstracts, indexes, lists of tables and figures, bibliography and appendices). The number of words is about 126,000 words.

Due to their complex thesis structure, most of the theses have several chapters including concluding sections or subsections with headings such as "Discussion", "Summary" or "Conclusion" related to a specific topic or case study. Only four theses in the corpus have a separate chapter titled "Discussion" (8.33%). However, all the theses have one or two separate final chapters with other titles. These closing chapters were selected for analysis.

The first stage of the study was about external organizational aspects. At the second stage, internal genre structures were investigated. A quantitative-qualitative approach examined the most frequent titles, the number of closing chapters used in the theses and the sections they were divided into. Then these final chapters were analyzed in terms of moves and steps.

The genre analysis of the data took into account lexical signals, propositional meanings and the overall purposes of each thesis. Although it is difficult to avoid subjectivity in such a qualitative study, the move-step structures were analyzed by inter-coder reliability to ensure high inter-rater agreement. One applied linguistics researcher, who shared my research interests, and myself acted as independent move-step coders. First, we created a move-step list to obtain a framework of analysis inspired on Yang and Allison's (2003), Bunton's (2005) and Kwan and Chan's (2014) classifications. Then, each of us carried out a preliminary round of coding independently. The analysis of the actual data led us to modify some labels of moves and steps and include new categories for segments which could not match the initial typology. Another round of independent coding was then undertaken. Finally, meetings between the two of us took place in which we developed our move-step typology. The texts were reanalyzed looking for as much reliability and consistency of the criteria as possible. Disputable cases were discussed until an agreement was reached both on the labels and the classification of the segments. To keep the analysis as simple as possible, we included neither embedded moves/steps nor sub-steps in our taxonomy.

4. Results and discussion

In this section, the findings of the analysis of the closing sections of the corpus are presented. First the number of closing chapters, the chapter titles and the divisions into sections and subsections are discussed. Then the move-step structures and sequences are described.

4.1. Analysis of chapter titles

Table 4 shows the titles of the closing chapters of the 48 PhD theses organized according to a thematic criterion. It also contains the number of theses sharing a title and the percentage of use in the corpus. All the final chapters are conventionally labeled, the most common labels being: "Conclusion(s)" (56.25% of the theses) and merged "Conclusion(s) and future/further work/outlook" (37.5%). Only two theses (T13, T38) end with "Discussion and conclusion(s)" labels (4.17%). One final concluding chapter appears in most of the theses (87.5%), but a minority of theses have two final chapters (12.5%) with the following generic titles: "Conclusion" and "Future work" (T36), "Future work" and "Conclusion" (T6, T16, T30), "Summary and conclusions" and "Future work" (T21), and "Future directions" and "Conclusions" (T25). In line with Bunton's (2005) conclusions, the titles corroborate the significant role of the free-standing closing conclusion(s) chapter in the thesis genre.

Title	Theses	Total number of theses	%
Conclusion(s)	T1, T3, T6, T8. T9, T10, T11, T12, T15, T16, T17, T18, T19, T20, T23, T25, T28, T30, T31, T33, T35, T36, T40, T41, T42, T44, T47	27	56.25
Future work	T6, T16, T21, T30, T36	5	10.42
Future directions	T25	1	2.08
Conclusion(s) and future/further work/outlook	T2, T4, T5, T7,T9, T22, T27, T28, T14,T29,T32, T34, T37, T39,T43, T45,T46, T48	18	37.5
Conclusions and future research directions	T24	1	2.08
Discussion and conclusion(s)	T13, T38	2	4.17
Summary and conclusions	T21	1	2.08

Table 4. Titles of the concluding chapters of 48 PhD theses in computer science with numbers and percentage of use.

4.2. Analysis of sections and subsections

The length of the thesis and the complexity of the research often require divisions of the chapters into sections and subsections in order to organize contents with clarity. At a second stage of the analysis, I examined the divisions and subdivisions of the chapters.

The conclusion chapters of 42 theses in the corpus have sections (85.5%) and 19 theses in the corpus have from two to six sub-sections (39.6%). Table 5 shows the number of sections in the conclusion chapters. The data about the six theses with two closing chapters refer to the chapters including the word "conclusion(s)" in their title (the six separate chapters about future work containing from zero to five sections). Most of the chapters are divided into two to four sections (58.33%). The most usual structure is that of three sections (25%).

Number of sections	Theses	Number of theses	%
0[1]	T7, T6, T5, T21, T25, T35	6	12.5
1	T20, T33, T34	3	6.25
2	T8, T16, T22, T30, T32, T24, T46	7	14.58
3	T11, T12, T15, T18, T23, T26, T31, T36, T39,T41, T42, T44,	12	25
4	T2, T3, T14, T17, T28, T29, T37, T43, T45	9	18.75
5	T4, T9, T19, T40	4	8.33
6	T27, T38, T48	3	6.25
7		0	0
8	T13	1	2.08
9	T1	1	2.08

Table 5. Number of sections in each conclusion chapter.

The section headings and subheadings in the conclusion chapters of the theses in the corpus were also examined. I suspected this analysis could provide a macro-level framework of text organization aligned with the choice of linguistic patterning, which is situated at the root of the move-step scheme for the concluding chapters of a thesis. The analysis revealed that the majority of section headings are generic, while most of the subheadings are topic-specific. Topic-specific section headings also predominate in the separate chapters about future work of the theses with two closing chapters.

Table 6 presents the section headings used in the conclusion chapters. As stated previously, the concluding chapters of six theses in the corpus are not divided into sections, and so no section heading is found in them. In addition, in the concluding chapters of 25 theses there is an initial paragraph that restates the work done, purpose, method and/or the main results and usually presents the chapter structure (59.5%). This introductory paragraph has no heading, except in the conclusion of T1, where it is labelled "Preamble". The varied headings of the subsequent sections show that there is freedom to decide on the words and also on the organization of the information in the concluding chapters of a thesis. However, Table 6 shows that some words in the section headings predominate (although combined differently in the corpus), revealing the main purposes of the chapter: summary, contributions, future work, closing remarks. This suggests that summarizing the work done in the thesis and the contributions to research in the field, together with suggestions for future research and final remarks are obligatory in the closing chapters of the PhD theses under study. However, this does not mean that, for example, sections titled "Contributions" only include the description of some novel or efficient computing product like an algorithm, system architecture, model or technique that was proved to work, solved a problem or had good performance. Likewise, sections under the heading "Future work" do not only contain a list of recommendations for further research. In fact, the move analysis revealed more complex structures.

Section headings	Theses	Total number of theses
No section heading/Preamble	T1, T2, T3, T4, T8, T10, T12, T13, T14, T16, T17, T20, T29, T30, T31,T33, T34, T36, T38, T39, T41, T43, T44, T45, T47	25
First section heading		**41**
Introduction	T1, T19, T27, T37, T48	5
Chapter summary	T23	1
Review of the thesis/(Thesis)review/summary (of thesis/work)	T11, T13, T14, T15, T17, T38, T39, T40, T41	9
Summary of objectives	T18	1
Motivation revisited	T4	1
Thesis statement (revisited)	T12, T43, T29	3
Summary of findings	T44	1
Summary of GP modelling approach	T3	1
(Principal) conclusion(s)	T24, T42, T46	3
(Thesis) contributions	T2, T16, T30	3
Contributions and conclusions	T22, T26, T32	3
Limitations	T8, T28	2
Limitations and future work	T33	1
Future/further work	T21, T34, T45	3
Outstanding issues and implementations	T20	1
Implicit feedback	T45	1
Topic specific	T9, T47	2
Second section heading		**39**
(Thesis) summary (of thesis)	T19, T30	2
Thesis statement revisited	T37	1
Research Question 1	T35	1
Significant results	T13, T38	2
Contributions/Novel contributions to research	T2, T11, T18, T29, T36, T40, T41, T43	8
Measures of success	T23	1
Directions for future work/Future research directions	T15, T22, T26, T32	4
Limitations	T24	1
Future work	T17	1
Strengths and limitations of the approach	T8, T12, T28, T46	4
Recommendations to developers	T3	1
Overview of research aim, objectives and programme	T48	1
Conclusion	T39, T14	2
Closing	T47	1
Topic-specific	T2, T4, T9, T20, T22, T34, T44	7
Third section heading		**31**
Dissertation summary	T40	1
Answering the thesis statement	T15	1
Research Question 2	T13, T38	2
Research contributions	T4	1
Summary of research contributions	T48	1
Evaluation	T36	1
Summary and conclusions	T12	1
Further results	T2	1
Limitations	T14	1

Future work	T17, T18, T29, T31, T35, T39, T41, T42, T43, T44	10
Scope for future work	T3	1
Future directions for research	T37	1
Guidelines	T19	1
Future work and improvements	T23	1
Closing remarks	T26	1
Conclusion	T11	1
Topic-specific	T1, T9, T27, T28, T47	5
Fourth section heading		**18**
Research Question 3	T13, T38	2
Summary	T29, T47	2
Limitations of the research	T48	1
Future work	T2, T4, T14, T40	4
Limitations and future work	T19	1
Closing remarks	T28	1
A final thought	T17	1
Conclusion(s)	T3, T37	2
Summary and conclusions	T43	1
Topic-specific	T1, T9, T27	3
Fifth section heading		**9**
Research Question 3	T13	1
The framework	T38	1
Directions for future research	T48	1
Conclusions	T4	1
In closing	T40	1
Final remarks	T19	1
Topic-specific	T1, T9, T27	3
Sixth section heading		**5**
Guidelines	T13	1
Conclusions	T38	1
Concluding remarks	T48	1
Topic-specific	T1, T27	2
Seventh section heading		**2**
Ethical implications	T1	1
Future work	T13	1
Eighth section heading		**2**
Future work	T1	1
Conclusions	T13	1
Ninth section heading		**1**
Summary	T1	1

Table 6. Organization of the information in the conclusion chapters according to section headings.

4.3. Analysis of move structure

In this section the move structure of the closing chapters in this corpus of computer science PhD theses is presented.

Table 7 shows the five-move model for the closing chapters and the number of theses containing each move. For the six theses with two closing chapters, the moves in both chapters were included in the counting in order to obtain the complete picture of each thesis. With reference to this, as also found by Yang and Allison (2003), we must indicate that the moves found in the separate chapters dealing with future work match the corresponding moves in the separate conclusion chapters, which means that these chapters draw on the same moves. Moreover, the moves can be used across chapters in the theses with two final closing chapters, and even sections, in the theses with one unique concluding chapter.

The dominant moves are M1, M2 and M4, present in 100%, 100% and 95.83% theses respectively. In his analysis of the move structure of computer science RAs, Posteguillo (1999) found that concluding sections were built on two main moves: the "statement of results"and the "recommendation for further research" moves. However, this study revealed that the bulk of the conclusion of the PhD theses in the corpus comprises three moves: the review of the research carried out (M1), the presentation of the results of implementing a computing model, technique or algorithm (M2) and the suggestions for future research (M4). Unlike the 25 science and technology theses of Bunton's (2005) study, which did not use a concluding restatement (only one thesis-oriented PhD conclusion presented it), more than half of the computer science theses in the corpus (60.42%) also have a final move recapitulating the overall study and contributions (M5). In contrast, M3 is used as a separate move by only half of the thesis writers in the corpus, probably because it is part of the thesis research itself as much research in computer science focuses on simulations and applications of a computing approach, model, algorithm or system architecture, thus evidencing practical applications and implications. This perhaps made Bunton regard M3 as often embedded in M2 in the science and technology conclusions. However, although M3 can be considered to be embedded in M2 in some cases in the corpus, the sequence of move patterns allows us to treat it as a separate independent move used cyclically in combination with other moves.

The moves are used in recurrent patterns in the closing chapters of 47 theses (only T25 presents the structure M1-M2-M4). The length of each thesis affords the writer space in which to discuss any decision, noteworthy results and suggestions and allows for a number of move-step cycles at different levels (the thesis, each thesis chapter, the whole study). This helps to keep the reader aware of the contribution of the current research, thus facilitating the selective reading of the thesis to the examiners. M1-M2 cycles are typically used in the corpus because the thesis writers present the specific work done in each thesis chapter together with the findings, products and claims directly related to it. Although less frequently used, other cycles are M1-M4, M2-M4, M4-M3, M4-M5 and M5-M4.

Move	Number of theses	%
Move 1: Revisiting the study	48	100
Move 2: Consolidating the research space	48	100
Move 3: Suggesting practical applications/implications	24	50
Move 4: Extending research in the existing territory	46	95.83
Move 5: Recapitulating the overall study	29	60.42

Table 7. Moves used in the closing chapters of the computer science PhD theses.

4.4. Analysis of step structure

Tables 8 to 12 show the steps found in the corpus and the frequency of the steps in each move. As done with the analysis of moves for the theses with two closing chapters, the move steps in both chapters were included in the counting to obtain the complete picture of each thesis.

Step	Number of theses	%
1.Presenting the work carried out in the thesis	40	83.33
2.Restating the purpose of research/research questions or hypothesis/thesis statement	27	56.25
3.Justifying the work carried out in the thesis/chapter	5	10.42
4.Restating the territory	20	41.67
5.Restating centrality	7	14.58
6.Restating the focus of the study	13	27.08
7.Restating the problem/need	27	56.25
8.Restating the method	23	47.92
9.Making references to previous research	12	25
10.Previewing the chapter or section	23	47.92
11.Summarizing the specific work reported in each thesis chapter	35	72.92

Table 8. Move 1: Revisiting the study.

The main function of M1 is to remind the reader of the study and summarize what has been done through the thesis (Yang & Allison, 2003; Lewkowicz, 2012). Bunton's (2005) findings for the set of science and technology theses showed that only the step restating the work carried out was present in at least 50% of the PhD conclusions. However, the results of this analysis reveal that four steps in M1 are used by more than 50% of the thesis writers: Step 1 "Presenting the work carried out in the thesis", Step 2 "Restating the purpose of research/research questions or hypothesis/thesis statement", Step 7 "Restating the problem/need", and Step 11 "Summarizing the specific work reported in every thesis chapter". Some examples of these steps are:

M1 Step 1:

We have presented various different approaches for applying model checking to ABL systems. T14

In this thesis, we have introduced bigraphs with sharing, a novel generalization of Milner's bigraphs specifically conceived to enable a direct representation of spatial locations shared among several entities. T30

This thesis has described the development of a tool which allocates jobs to resources according to an assessment of suitability which takes into account a wider range of information than other comparable tools, such as the Workload Management System (WMS). T32

M1 Step 2

This dissertation was opened by posing two research questions. These were intended to focus the research such that it might lead to potential solutions to the problems. These research questions were stated in section 1.1:

RQ1. How can the results of human computation be improved to match the specific needs of other systems?

RQ2. How can human computation be extended to collect and classify useful contextual information in mobile environments? T10

The research aim of this work was defined in the introductory chapter as:

To investigate and design a network routing structure and protocol suitable for assisting in the delivery of large scale content services such as video streaming services in a more efficient and localized manner exploiting localized resources and services where available. T37

The thesis statement postulated that both structures and field-based user studies are an effective methodology in developing new algorithms and visualization techniques for biological research. T47

M1 Step 7

The dynamic routing problem, finding an optimal route between arbitrary pairs of nodes in spite of network dynamics, poses a unique challenge complexity. T15

In transferring systems from the laboratory to end users, a number of challenges arise: designers will likely not have easy access to individuals, there are a myriad of individual differences which means systems must be customized for each individual, and carrying out user studies with BCI is costly. T28

Step 11

In chapter 4, we proposed a novel news search framework that describes the search process of a universal Web search engine and supports a news vertical […] In chapter 5, we presented the diverse datasets that were used to validate our thesis statement […] In chapter 7, we investigated the News Query Classification component of our news search framework… T19

Step	Number of theses	%
1.Preview of chapter	2	4.17
2.Describing the method of research/procedure	35	72.92
3.Presenting findings, results, answers to RQs, confirmation of thesis statement, solutions	45	93.75
4.Presenting product (model/approach/algorithm/system)	32	66.67
5.Comparing results with those reported in the literature	9	18.75
6.Accounting for results	10	20.83
7.Interpreting results	10	20.83
8.Exemplifying	2	4.17
9.Evaluating results	2	4.17
10.Establishing the claim	26	54.17
11.Evaluating product (model/approach/algorithm/system)	18	37.5
12.Indicating significance of product (model/approach/algorithm/system)	10	20.83

Table 9. Move 2: Consolidating the research space.

In M2 the thesis writer consolidates the research space s/he intended to occupy and presents the achievements and results of the study. The main objective is to show how the findings and work done contribute to the research field. In computer science research can be oriented towards evaluating the results of applying existing approaches to new situations or towards proposing a new method, algorithm or system architecture able to improve performance in a specific setting. It was observed that many theses in the corpus present both kinds of contributions. They present results based on a certain method and propose new products that prove more effective or beneficial, or vice versa. Four from 12 possible steps in M2 are most often selected. Typically, the theses either "describe the method of research used" (Step 2), "present results" (Step 3) and "establish claims" (Step 10), and/or "present a new computer model, approach, algorithm or system" (Step 4). "Evaluating the product" (Step 11, 37.5%) is also used at higher frequency than the rest of steps. M2 is lengthy and involves much detail. M2 Step 3 patterns occur frequently in the corpus, as the writers profusely report on the results in each thesis chapter, showing they are aware of the need to highlight the contribution of their research in order to appeal to the examiners. Some examples of these steps are:

M2 Step 2

Continuous, transparent authentication has the potential to provide a secure environment that allows security provision to remain largely in the background, and to help alleviate the memory and task load of the device owner. In this way, it becomes another tool in a developer's authentication and security toolbox. T4

The presented techniques included a novel mapping of exhaustive search to a constraint satisfaction problem and a hill climbing local search algorithm. T26

M2 Step 3

[…] we have theoretically demonstrated that it is possible to look at exhaustivity and specificity as two views of the same aboutness property and not as two different aboutness relations […] We have found that all analyzed filters intersect with their underlying aboutness systems […] For XML vector space retrieval model, for instance, we could show how the brute –force filter eliminates many of its advanced reasoning capabilities. T1

M2 Step 10

Simulation is thus shown to be a useful tool for estimating task performance. T28

Overall, the results of the evaluation suggest that the prediction of topic relevance, using the above approach, is feasible and to a certain extent implicit feedback models can benefit by incorporating such affective features. Furthermore, the integration of affective features could facilitate a more natural and meaningful interaction, improve the quality of the query suggestions, as well as influence other facets of the information seeking process […] The findings suggest that affective feedback, as determined from facial expression analysis, can significantly improve the performance of a recommender system over other popular feedback techniques. T44

Another contribution is the use of semantics to identify recommendations. As our evaluation indicated, semantic recommendations can successfully be employed to improve the recommendation quality. T45

Move 2 Step 4

Using the common designs of previous systems as a guideline, a game with by-products was built called EyeSpy. A particular contribution of this research was that, unlike previous games with by-products, EyeSpy was set in a mobile environment and had the players create, validate and label image by-products that were contextually relevant to that environment. T10

Derived from this study, one contribution of this work is a model for exploiting community-based usage information for video retrieval […]. T45

From these more detailed findings and from within the literature review, a higher-level framework was created that designers can use when designing to support impression management. T46

Move 2 Step 11

This system proved successful in producing useful by-products and being enjoyable to play. T10

The experimental studies reported in Chapters 5-7 indicated that HDS leads to good estimations of the relative arithmetic means of all the numerical values in each row or column, regardless of the size of the table, achieving 80%-90% accuracy in most cases. T42

Comparisons with related literature (M2 Step 5) and comments on results are not a priority (M2 Steps 6, 7, 8 and 9), as also found by Posteguillo (1999) in his study of RA discussion/conclusion sections in computer science. Contrary to the findings in Basturkmen (2009) for dissertations in language teaching, the writers of the computer science theses do not usually compare results obtained in the study with results in the literature (Step 5, 18.75%) nor offer explanations for results (Step 6, 20.83%), but highlight their own findings in the closing chapters of their thesis. This could be related to the fact that there is not much previous research work which may be referred to (because the thesis reports novel research or new applications), and also that explanations have been provided at length in the previous chapters of the theses.

Step	Number of theses	%
Proposing applications or implications	24	50

Table 10. Move 3: Suggesting practical applications/implications.

As previously stated, M3 is the least frequently used move in the corpus. Much of the research in computer science deals with applying a computer approach/system/model to new uses or in new situations. Thus, M2 and M3 are interrelated. The only step in M3 is found isolated from M2 in only 50% of the closing chapters. These are two examples from the corpus:

This study can be of benefit to any proxemic interaction or context-aware systems that explore the use of mobile inertial sensors and external position sensing device for user matching and identification […] for instance, the system has the potential to be used in a family environment to provide personalized multimedia services and TV programs to each family member when the system matches a skeleton with a personal device through his/her everyday movements. T9

> The openness and dynamism of Domino's system architecture is applicable to a variety of systems, but is especially appropriate for mobile systems because of their variety and unpredictability of patterns of use, their frequent disconnection from fixed networks, and their relatively limited amount of memory. T40

Step	Number of theses	%
1.Preview of section/chapter	8	16.67
2.Indicating limitations	32	66.67
3.Relating to existing research	10	20.83
4.Planning further actions	7	14.58
5.Recommending future work (guidelines for continuing research)	44	91.67
6.Overviewing the chapter	2	4.16

Table 11. Move 4: Extending research in the existing territory.

M4 suggests further research on the topic and can be considered to be obligatory in the closing chapters of the computer science theses. Generally, the writers admit limitations in the study (Step 2, 64.58%) or simply suggest future action (Step 5, 93.75%). Less frequently, the writers mention their plans for further action (Step 4, 14.58%) and make references to existing research (Step 3, 20.83%) to provide a link between the previous work in a specific area and the suggested further research.

Step	Number of theses	%
1.Previewing the chapter/section	1	2.08
2.Reiterating the overall purpose/research questions or hypothesis/thesis statement	9	18.75
3.Reiterating the problem/need	4	8.33
4.Reiterating the method	7	14.58
5.Recapitulating the work carried out	15	31.25
6.Reiterating the significance of the work carried out	2	4.16
7.Highlighting overall claims/findings	25	52.08
8.Summarizing recommendations for future work	2	4.16

Table 12. Move 5: Recapitulating the overall study.

M5 recapitulates the study and summarizes the contents of the closing chapters. The most usual steps are Step 7 "Highlighting overall claims/findings" (52.08%) and Step 5 "Recapitulating the work carried out" (31.25%). The writer aims at reviewing the thesis work and highlighting her/his claims and achievements. Examples of M5 Step 7 are:

> The presented methodology can help in the early stages to structure design approaches and develop evaluation techniques. T1
>
> The evaluations presented in this thesis make a significant contribution to the understanding of how users make decisions about performative interactions in real world settings. T36
>
> This thesis has provided the first detailed experimental investigations into the design of crossmodal icons. […] this is the first time that this approach has been applied to the design of audio and tactile icons. T43

4.5. Move and step sequences and cycles

The M1-M2-M3-M4-M5 sequence used in the model of analysis reflects the most widely used order in which the moves appear in the texts, from most specific information reviewing the thesis work to open suggestions derived from the work done and final remarks. However, this sequence of moves is altered in some cases. For example, M4 precedes M1 in T25, and is presented in medial positions after M1-M2 cycles or in cycles with either M1 or M2 in eight theses (T2, T5, T6, T10, T12, T27, T30 and T32).

The most frequent cycles of moves in the concluding chapters involve a review of the work done (M1) and of the results and contributions (M2). In 35 theses the specific work carried out in each chapter is reviewed (M1-Step 11) and the partial results obtained in each chapter are presented in turn (M2-Step 3). An example of this pattern is found in T29.

> M1 Step 11. Chapter 4 reported an experiment investigating the effect of layout aesthetics on performance and preference, as well as the relationship between preference and performance.
>
> M2 Step 3 […] results showed that, regardless of the search tool used performance (as represented by response time) increased with higher aesthetics levels, and decreased with lower aesthetics levels […].
>
> M1 Step 11. Chapter 5 reported an experiment investigating participants' preferences with fifteen layout metrics […]
>
> M2 Step 3 Results showed that there was a large variation in preferences, which indicated that it is difficult to predict interface preference precisely […].
>
> M1 Step 11. Chapter 6 reported an experiment investigating visual effort with respect to layout aesthetics.
>
> M2 Step 3 […] the results associated with the three levels of aesthetics

showed that visual effort increased at lower aesthetics and decreased at higher aesthetics level […].

M1 Step 11. Chapter 7 reported an experiment investigating the relationship between classical layout aesthetics and background image expressivity.

M2 Step 3. The results showed that in the context of classical aesthetics, performance was highest at high and low levels of aesthetics and worse at medium levels of aesthetics. T29

Other more complex organizations recur repeatedly to various steps both in M1 and M2 at the thesis and the chapter level. First, they review the work done in the thesis (M1 Step 1) and the thesis statements or initial research questions (M1 Step 2). Second, the specific work done (M1-Step 11) is revisited and the findings (M2 Step 3) or new products (M2 Step 4) are presented as confirmations of the thesis statements or answers to the research questions. One explanation to this may be that the writers assume that the examiners read the introduction and conclusions chapters so as to have a clear idea of what the thesis is about before reading the whole text. An example of this pattern is found in T42:

M1 Step 2. Research Question 1 asked:

How can overview information from tabular numerical data sets be obtained non-visually?

M1 Step 11. RQ-1 was addressed firstly through a review of the literature on current accessibility tools and technologies available for visually impaired users, as well as new accessibility techniques for numerical information that are under development. Secondly a user-centered requirements capture process […] provided a list of requirements. These requirements were later applied in the design of the techniques that form the main contributions of this thesis.

M2 Step 3. Experiments reported in Chapters 5 to 8, in addition to providing quantification of the performance attainable with these techniques (thus responding to RQ-2 of the thesis, as summarized in Section 9.2.2 below), also provided information that contributed to further answering RQ-1. These findings are summarized below […]

M1 Step 2. Research Question 2 asked:

What level of performance can be achieved with the techniques proposed in this thesis?

M1 Step 11. RQ-2 has been addressed through the empirical studies reported

> in Chapters 5, 6, 7 and 8. These chapters reported a series of experiments which investigated the performance which could be attained in the exploration of tabular data sets for overview information using HDS as implemented in TableVis. […]
>
> M2 Step 3. The findings of each experimental study, and how these relate to RQ-2, are summarized below […] T42

In M4, alternating recurrent steps are found: Step 2 "Limitations of the study" and Step 5 "Suggestions for further research" patterns acknowledge the limitations and suggest future research for each of the research actions presented in the thesis.

Such cyclicity and recurrence of patterns causes the same propositions and contents to be repeated throughout the closing chapter. The variety of patterns suggests that writers may organize their closing chapters with a certain amount of flexibility and freedom. However, repetitive contents might also indicate that writers do not know exactly how to treat the information and certain tuition could be useful.

5. Conclusions

In this study I analyzed how computer science doctoral writers construct the closing chapters of 48 PhD theses defended at the University of Glasgow using a qualitative-quantitative approach and a move-step framework. The results corroborated partly the earlier research findings about the concluding chapters of theses. I found that most theses have only one final concluding chapter, usually titled "Conclusion(s)", which is divided into sections and subsections. The section headings are generic, while the subheadings are topic-specific.

Another finding was that the writers of the computer science PhD theses organize the contents of the closing chapters around M1-M2-M4 sequences that review the thesis work (M1), focus on the results and products developed one by one (M2) and make recommendations for further research related to every aspect under analysis (M4), thus allowing for cyclical patterns. This result is consistent with Bunton's (2005) results for a corpus of science and technology PhD conclusions. However, contrary to Bunton's data, I also found that reiterating overall findings and claims in M5 occurred frequently in the computer science PhD conclusions.

Move-step patterns are repeated throughout the computer science PhD concluding chapters. Three of the possible steps in M1 are used frequently, and they are: Step 1 "Presenting the work carried out in the thesis", Step 2 "Restating the purpose of research/research questions or hypothesis/thesis statement", Step 7 "Restating the problem/need" and Step 11 "Summarizing the specific work reported in every thesis chapter". The most common steps in M2 are Step 2 "Describing the method of research/procedure", Step 3 "Presenting findings, results, answers to research questions, confirmation of thesis statement, solutions", Step 4 "Presenting product (model/approach /algorithm/system)", Step 10 "Establishing the claim" and Step 11 "Evaluating product (model/approach/algorithm/system)". In M5, Step 7 "Highlighting overall claims/findings" and Step 5 "Recapitulating the work carried out" are the most frequently present. A possible reason for the strong presence of these steps in these theses is that the writers make efforts to promote their research and show that the results and products presented are an improvement in the field. If we compare these findings to research in other disciplines, differences emerge. Indeed, the results in this study contrast with Basturkmen's (2009: 249) conclusions on language teaching dissertations, pointing out that the writers might not find it necessary to highlight the value of their research because of the limited audience of the supervisor and the examiners. The findings in this study also differ from Lewkowicz's (2012) results on a set of 12 thesis conclusions in English studies written in Polish. Lewkowicz concluded that the writer's major aim was to remind the reader of important points in individual chapters rather than consolidate the research space. However, it seems that the computer science community expects thesis writers to emphasize the contribution to the field.

Given the complex structure of certain concluding chapters, full of move-step cycles and recurrent ideas, some guides related to the specific genre conventions could prove beneficial. EAP courses could encourage practice in the PhD genre and critical reflection on the relationships which are established between the thesis writer and the board of examiners. Students of research writing should be informed of move-step structures which are typical of the PhD closing chapters. Students should also learn about the specific characteristics of the field of computer science. Teaching materials could be prepared on a selection of concluding chapters in the discipline. Activities based on authentic materials should focus on the purposes and patterns most often found in the conclusions of PhD theses in computer science. This could raise the students' rhetorical consciousness and understanding of the conventions of the discipline and would help them in their own writing. Drawing from a move-step model, students could discuss on the organization of the chapters and the function of the moves and steps. Comparing the variety of patterns could help them discover effective strategies to write their own conclusion chapters.

This study on PhD thesis concluding chapters in computer science has been limited to only one university, which affects the generalizability of the findings. Plans for future research concern enlarging the corpus and investigating variation across languages, disciplines and university institutions. Another aspect worth of future investigation would be to compare the introduction and the conclusions chapters of the theses.

This work contributes to the genre of the PhD thesis by examining the rhetorical structure of separate PhD thesis concluding chapters within computer science and the move structure identified can be used as a model to guide students how to conclude doctoral theses.

Article history:
Received 14 September 2015
Received in revised form 20 December 2015
Accepted 23 December 2015

References

Asunción, T.Z.S. & M.B. Querol (2013). "Rhetorical moves in the introductions of masters' theses". *Graduate Research Journal* 6,1-2: 65-85.

Basturkmen, H. (2009). "Commenting on results in published research articles and masters dissertations in Language Teaching". *Journal of English for Academic Purposes* 8: 241-251.

Basturkmen, H. (2012). "A genre-based investigation of discussion sections of research articles in dentistry and disciplinary variation". *Journal of English for Academic Purposes* 11,2: 134-144.

Berkenkotter, C. & T. N. Huckin (1995). *Genre Knowledge in Disciplinary Communication: Cognition/Culture/Power*. Hillsdale, N.J.: Lawrence Erlbaum.

Bitchener, J. & H. Basturkmen (2006). "Perceptions of the difficulties of postgraduate L2 thesis students writing the discussion section". *Journal of English for Academic Purposes* 5: 4-18.

Bunton, D. (2002). "Generic moves in PhD thesis introductions" in J. Flowerdew (ed.), *Academic Discourse*, 57-75. London: Longman.

Bunton, D. (2005). "The structure of PhD conclusion chapters". *Journal of English for Academic Purposes* 4: 207-224.

Carbonell-Olivares, M., L. Gil-Salom & C. Soler-Monreal (2009). "The schematic structure of Spanish PhD thesis introductions". *Spanish in Context* 6,2: 151- 176.

Dudley-Evans, T. (1986). "Genre analysis: an investigation of the introduction and discussion sections of MSc dissertations" in M. Coulthard (ed.), *Talking about Text. Discourse Analysis Monographs* 13, 219-228. English Language Research: University of Birmingham.

Gil-Salom, L. & C. Soler-Monreal (2014b). "Writers' positioning in literature reviews in English and Spanish computing doctoral theses". *Journal of English for Academic Purposes* 16: 23-39.

Holmes, R. (1997). "Genre analysis and the social sciences: an investigation of the structure of research article discussion sections in three disciplines". *English for Specific Purposes* 16,4: 321-337.

Holmes, R. (2001). "Variation and text structure: The discussion section in economics research articles". *ITL Review of Applied Linguistics* 131-132: 107-135.

Kanoksilapatham, B. (2015). "Distinguishing textual features characterizing structural variation in research articles across three engineering sub-discipline corpora". *English for Specific Purposes* 37: 74-86.

Kwan, B. (2006). "The schematic structure of literature reviews in doctoral theses of applied linguistics". *English for Specific Purposes* 25: 30-55.

Kwan, B. & H. Chan (2014). "An investigation of source use in the results and the closing sections of empirical articles in Information Systems: In search of a functional-semantic citation typology for pedagogical purposes". *Journal of English for Academic Purposes* 14: 29-42.

Lewin, B.A. & J. Fine (1996). "The writing of research texts: Genre analysis and its applications" in G. Rijlaarsdam, H. van der Bergh & M. Couzjin (eds.), *Theories, Models and Methodology in Writing Research*, 423-444. Amsterdam: Amsterdam University Press.

Lewkowicz, J. (2009). "Concluding your master's level thesis". *Revista Canaria de Estudios Ingleses* 59: 63-72.

Lewkowicz, J. (2012). "The challenges of writing a successful thesis conclusion" in R. Tang (ed.), *Academic Writing in a Second or Foreign Language*, 107-125. London: Continuum International Publishing Group.

Lim, J.M.H. (2014). "Formulating research questions in experimental doctoral dissertations on Applied Linguistics". *English for Specific Purposes* 35: 66-88.

Lim, J.M.H., C.K. Loi & A. Hashim (2014). "Postulating hypotheses in experimental doctoral dissertations on Applied Linguistics: A qualitative investigation into rhetorical shifts and linguistic mechanisms". *Ibérica* 27: 121-142.

Lim, J.M.H., C.K. Loi, A. Hashim & M.S M. Liu (2015). "Purpose statements in experimental doctoral dissertations submitted to U.S. universities: An inquiry into doctoral students' communicative resources in language education". *Journal of English for Academic Purposes* 20: 69-89.

Lindeberg, A. (1994). "Rhetorical conventions in the discussion/conclusion sections of research articles in finance, management and marketing" in M. Brekke, O. Anderson, T. Dahl & J. Myking (eds.), *Applications and Implications of Current LSP Research. Proceedings of the 9th European LSP Symposium*, Bergen, Norway, August 1993, 761-779. Bergen, Norway: Fagbokforlaget.

Nwogu, K.N. (1997). "The medical research paper: Structure and functions". *English for Specific Purposes* 16,2: 119-138.

Paltridge, B. (2002). "Thesis and dissertation writing: An examination of published advice and actual practice". *English for Specific Purposes* 21: 125-143.

Peacock, M. (2002). "Communicative moves in the discussion section of research articles". *System* 30: 479-497.

Peng, J. (1987). "Organizational features in chemical engineering research articles". *ELR Journal* 1: 79-116.

Posteguillo, S. (1999). "The schematic structure of computer science research articles". *English for Specific Purposes* 18,2: 139-160.

Ridley, D. (2011). *The Literature Review. A Step-by-Step Guide for Students*, 2nd ed. London: Sage Publications.

Samraj, B. (2008). "A discourse analysis of master's theses across disciplines with a focus on introductions". *Journal of English for Academic Purposes* 7,1: 55-67.

Soler-Monreal, C. & L. Gil-Salom (2010). "Moves, steps and linguistic signals in RA Discussion sections". In W. Hahn & C. Vertan, C. (eds.), *Fachsprachen in der Weltweiten Kommunikation / Specialised Language in Global Communication. Series Sprache in der Gesellschaft, Band 30 / Language in the Society* 30, 519-528. Bern: Peter Lang.

Soler-Monreal, C., M. Carbonell-Olivares & L. Gil-Salom (2011). "A contrastive study of the rhetorical organisation of English and Spanish PhD thesis introductions". *English for Specific Purposes* 30,1: 4-17.

Soler-Monreal, C. & L. Gil-Salom (2014a). "Academic voices and claims. Reviewing practices in research writing". In L. Gil-Salom & C. Soler-Monreal (eds.), *Dialogicity in Written Specialised Genres*, 23-54. Amsterdam: John Benjamins.

Soler-Monreal, C. (2015). "Announcing one's work in PhD theses in computer science: A comparison of Move 3 in literature reviews written in English L1, English L2 and Spanish L1". *English for Specific Purposes* 40: 27-41.

Swales, J.M. (1990). *Genre Analysis: English in Academic and Research Settings*. Cambridge: Cambridge University Press.

Swales, J. & C. Feak (2004). *Academic Writing for Graduate Students*, 2nd ed. Ann Arbor, Michigan: The University of Michigan Press.

Thompson, P. (2009). "Literature reviews in applied PhD theses: Evidence and problems" in K. Hyland & G. Diani (eds.), *Academic Evaluation. Review Genres in University Settings*, 50-67. New York: Palgrave MacMillan.

Yang, R. & D. Allison (2003). "Research articles in applied linguistics: Moving from results to conclusions". *English for Specific Purposes* 22: 365-385.

Carmen Soler-Monreal is Senior Lecturer of English at the Universitat Politècnica de València, Spain. Her research interests include genre-based and contrastive analysis of academic writing in engineering fields. She has published articles in ESPJ and JEAP (Elsevier), SIC (John Benjamins) and IJES (Universidad de Murcia). In 2014, she was the co-editor of a monograph for John Benjamins on dialogicity in written specialised genres.

NOTES

[1] When the concluding chapters are not divided into sections, the number of sections is 0.

Appendix

List of computer science PhD theses defended at the University of Glasgow:

T1. Arapakis, I. (2010). *Affect-based Information Retrieval.*
T2. Blanke, T. (2011). *Theoretical Evaluation of XML Retrieval*.
T3. Cahir, C. (2014*). Approaches to Adaptive Bitrate Video Streaming*.
T4. Crawford, H. A. (2012). *A Framework for Continuous, Transparent Authentication on Mobile Devices*.
T5. Dempster, M. A. (2013). *An Information Analysis of the Interaction between Sensory Signals and Ongoing Cortical Activity Using a Novel Mechanistic Cortical Model, Behavioural and MEG Studies*.
T6. Donaldson, R. (2012). *Modelling and Analysis of Structure in Cellular Signalling Systems*.
T7. Dooner, M.T. (2012). *Towards a Robust, Passive Stereo Depth Sensor with Confidence and Intensity Guided Anisotropic Diffusion Disparity Refinement*.
T8. Elliott, D. (2011*). An Empirical Analysis of Information Filtering Methods*.
T9. Feng, S. (2014). *Sensor Fusion with Gaussian Processes*.
T10. Ferguson, J.U. (2011). *Mutually Reinforcing Systems*.
T11. Hall, M. (2008). *Contextual Mobile Adaptation*.
T12. Hamilton, G. (2014). *Distributed Virtual Machine Migration for Cloud Data Centre Environments*.
T13. Hoggan, E.E. (2010). *Crossmodal Audio and Tactile Interaction with Mobile Touchscreens*.
T14. Hopfgartner, F. (2010). *Personalised Video Retrieval: Application of Implicit Feedback and Semantic User Profiles*.
T15. Hutton, A.J. (2008). *An Empirical Investigation of Issues Relating to Software Immigrants*.
T16. Jakubowska, J. (2008). *Genome Visualisation and User Studies in Biologist-Computer Interaction*.
T17. Keir, P. (2012). *Design and Implementation of an Array Language for Computational Science on a Heterogeneous Multicore Architecture*.
T18. Kelly, T. (2014). *Unwritten Procedural Modeling with the Straight Skeleton*.
T19. Kildal, J. (2009). *Developing an Interactive Overview for Non-visual Exploration of Tabular Numerical Information.*
T20. Kirwan, R. F. (2014). *Applying Model Checking to Agent-based Learning Systems*.
T21. Koliousis, A.K. (2010). *An Elementary Proposition on the Dynamic Routing Problem in Wireless Networks of Sensors*.

T22. Macdonald, C. (2009). *The Voting Model for People Search*.
T23. MacIsaac, L.J. (2013). *Modelling Smart Domestic Energy Systems*.
T24. Manaseer, S. (2010). *On Backoff Mechanisms for Wireless Mobile Ad Hoc Networks*.
T25. McBryan, T. (2011). *A Generic Approach to the Evolution of Interaction in Ubiquitous Systems*.
T26. McCreadie, R. (2012). *News Vertical Search Using User-generated Content*.
T27. McDermid, E.J. (2011). *A Structural Approach to Matching Problems with Preferences*.
T28. McGinniss, I. (2013). *Theoretical and Practical Aspects of Typestate*.
T29. McIlroy, R. (2010). *Using Program Behaviour to Exploit Heterogeneous Multi-core Processors*.
T30. McKechnie, P.E. (2010). *Validation and Verification of the Interconnection of Hardware Intellectual Property Blocks for FPGA-based Packet Processing Systems.*
T31. McMillan, D.C. (2012). *Mass Participation User Trials*.
T32. Peng, J. (2010). *Learning to Select for Information Retrieval*.
T33. Perry, T.P. (2013). *Software Tools for the Rapid Development of Signal Processing and Communications Systems on Configurable Platforms*.
T34. Power, C. (2012). *Probabilistic Symmetry Reduction*.
T35. Pullinger, S. (2010). *A System for the Analysis of Musical Data*.
T36. Psarras, I. (2009). *Colombus: Providing Personalized Recommendations for Drifting User Interests*.
T37. Quek, M. (2013). *The Role of Simulation in Developing and Designing Applications for 2-class Motor Imagery Brain-computer Interfaces*.
T38. Salimun, C. (2013). *The Relationship between Visual Interface Aesthetics, Task Performance, and Preference*.
T39. Sevegnani, M. (2012). *Bigraphs with Sharing and Applications in Wireless Networks*.
T40. Shannon, M. (2011). *The Construction of High-performance Virtual Machines for Dynamic Languages.*
T41. Sherwood, S.C. (2008). *Designing to Support Impression Management*.
T42. Steward, G.P. (2012). *Optimisation Strategies for Large-scale Distributed Computing and Data Management in the Presence of Security and Other Requirements*.
T43. Strowes, S.D. (2012). *Compact Routing for the Future Internet*.
T44. Thompson, K.R. (2009). *Implementation of Gaussian Process Models for Non-linear System Identification*.
T45. Trinder, J.J. (2012). *Mobile Learning Evaluation: The Development of Tools and Techniques for the Evaluation of Learning Exploiting Mobile Devices through the Analysis of Automatically Collected Usage Logs-an Iterative Approach*.
T46. Unsworth, C. (2008). *A Specialised Constraint Approach for Stable Matching Problems*.
T47. Williamson, J.R. (2012). *User Experience, Performance, and Social Acceptability: Usable Multimodal Mobile Interaction*.
T48. Windmill, C.M. (2013). *Hierarchical Network Topographical Routing*.