WRITING AND PUBLISHING PROCESS OF A MULTIDISCIPLINARY MULTI-AUTHORED RESEARCH ARTICLE

ALI DERAHVASHT

THESIS SUMBITTED IN FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

FACULTY OF EDUCATION

UNIVERSITY OF MALAYA

KUALA LUMPUR

2017

UNIVERSITY OF MALAYA

ORIGINAL LITERARY WORK DECLARATION

Name of Candidate: **Ali Derahvasht**

Registration/Matric No: **PHA 100029**

Name of Degree: **PhD**

Title of Project Paper/Research Report/Dissertation/Thesis ("this Work"):

WRITING AND PUBLISHING PROCESS OF A MULTIDISCIPLINARY MULTI-AUTHORED RESEARCH ARTICLE

Field of Study: **TESL**

I do solemnly and sincerely declare that:

(1) I am the sole author/writer of this Work;
(2) This Work is original;
(3) Any use of any work in which copyright exists was done by way of fair dealing and for permitted purposes and any excerpt or extract from, or reference to or reproduction of any copyright work has been disclosed expressly and sufficiently and the title of the Work and its authorship have been acknowledged in this Work;
(4) I do not have any actual knowledge nor do I ought reasonably to know that the making of this work constitutes an infringement of any copyright work;
(5) I hereby assign all and every right in the copyright to this Work to the University of Malaya ("UM"), who henceforth shall be owner of the copyright in this Work and that any reproduction or use in any form or by any means whatsoever is prohibited without the written consent of UM having been first had and obtained;
(6) I am fully aware that if in the course of making this Work I have infringed any copyright whether intentionally or otherwise, I may be subject to legal action or any other action as may be determined by UM.

Candidate's Signature Date

Subscribed and solemnly declared before,

Witness's Signature Date

Name:
Designation:

ABSTRACT

This study aims to explore the writing and publishing process of a multidisciplinary multi-authored research article. Participants of this case study were a team of eight multidisciplinary researchers in chemistry, physics, and engineering in a leading research university in Malaysia. The participants conducted their research project during five months. They produced nine drafts of the article until the final draft was published in an on-line journal. Two theoretical frameworks guided this study. Larsen-Freeman & Cameron (2008) provided the main theoretical lens for seeing the entire process of writing and publishing a research article as a system of interrelated components. Additionally, Grabe & Kaplan's (1997) model of writing was another framework used for the analysis of text, comprising the nine drafts of the research article. This case study benefited from a naturalistic method of enquiry and qualitative approach in conducting observations, interviews, and collection of documents and other artifacts which provided the sources of data. The multiple authors were interviewed mostly after their laboratory experiments, team discussions, or production of drafts in order to cross check the findings from observations and drafts of the article. The collected data were coded and later categorized and the themes were emergent from the categorized data. In the analysis of findings, the themes were supported by triangulation of data. Findings from the analysis of data revealed that in doing the authentic task of writing and publishing a research article, writing and publishing are not two separate processes, and the end of one is not the beginning of the other. Instead, writing and publishing are two integrated processes, each comprising several sub-processes such as data collection, submission of final drafts to journals, and peer-review of drafts. The findings also unveiled the complexities within the process of writing and publishing multidisciplinary multi-authored research article. Among the findings were issues related to authorship, multiplicity of authors, and multidisciplinary nature of today's research. Although many scholars have examined authorship, this study revealed that co-authoring a multidisciplinary multi-authored research article depends on many unpredictable aspects and requires adequate precautions and considerations. Interviews showed that segments of the multi-authored text were frequently shaped and re-shaped by the multiple authors of the research article who were from different disciplines. A central theoretical contribution of this study is that the multiplicity of writers (authors) were added to the model of writing which originally looked at single-authored texts. This helped in better understanding of the complexities in shaping and re-shaping the research article text. In addition to awareness-building, pedagogical implications of this study include providing the principles of authorship for novice researchers, and several lessons for conflict management during the process of co-authoring research papers. Another implication involves suggestions of the content of a workshop for staff improvement. Additionally, recommendations for professional practice and future research on writing-for-publication of research articles are provided in the final chapter of this study.

PROSES PENULISAN DAN PENERBITAN ARTIKEL PENYELIDIKAN OLEH PELBAGAI PENGARANG DARIPADA PELBAGAI DISIPLIN

ABSTRAK

Kajian ini bertujuan untuk meneroka proses penulisan dan penerbitan artikel penyelidikan pelbagai pengarang daripada pelbagai disiplin. Peserta kajian kes ini adalah terdiri daripada sepasukan lapan penyelidik pelbagai disiplin dalam bidang kimia, fizik dan kejuruteraan di sebuah universiti penyelidikan terkemuka di Malaysia. Mereka menjalankan projek penyelidikan selama lima bulan. Mereka menghasilkan sembilan draf artikel sehingga draf akhir diterbitkan di jurnal dalam talian. Kajian ini berpandukan kepada dua rangka kerja teoritikal. Larsen-Freeman & Cameron (2008) menyediakan lensa teoritikal utama untuk melihat keseluruhan proses penulisan dan penerbitan artikel penyelidikan sebagai satu sistem komponen yang saling berkaitan. Tambahan, model penulisan Grabe & Kaplan (1997) juga digunakan sebagai rangka kerja bagi menganalisa teks yang terdiri daripada sembilan draf artikel penyelidikan. Kajian kes ini mendapat manfaat daripada kaedah naturalistik persoalan dan pendekatan kualitatif dalam menjalankan pemerhatian, temu bual, dan pengumpulan dokumen dan artifak yang menjadi sumber data. Setiap pengarang telah ditemuramah selepas mereka menjalankan eksperimen makmal, perbincangan pasukan, atau penghasilan draf untuk menyemak dapatan daripada pemerhatian dan draf artikel. Data yang diperolehi telah dikod dan kemudian dikategorikan. Tema kajian diperolehi daripada data yang dikategorikan. Dalam analisis dapatan, tema disokong oleh triangulasi data. Dapatan daripada analisis data menunjukkan bahawa dalam menjalankan tugasan penulisan dan penerbitan artikel penyelidikan, keduanya bukan proses yang berasingan. Sebaliknya, penulisan dan penerbitan adalah dua proses bersepadu yang terdiri daripada beberapa sub-proses seperti pengumpulan data, penyerahan draf akhir untuk jurnal, dan semakan semula draf. Dapatan kajian juga mendapati adanya kekangan dalam penulisan dan proses penerbitan artikel penyelidikan oleh pengarang daripada pelbagai disiplin. Antara dapatan yang diperolehi adalah isu-isu yang berkaitan dengan penulisan, kepelbagaian pengarang, dan sifat pelbagai disiplin penyelidikan hari ini. Walaupun ramai para akademik telah memeriksa pelbagai bentuk penulisan, kajian ini mendapati bahawa untuk mengarang bersama artikel penyelidikan yang ditulis oleh pengarang pelbagai disiplin bergantung kepada aspek yang tidak dijangka dan memerlukan langkah berjaga-jaga dan pertimbangan yang mencukupi. Temu bual menunjukkan bahawa teks penulisan pengarang kerap disunting dan disunting semula oleh pelbagai pengarang artikel penyelidikan daripada bidang yang berbeza. Sumbangan teoritikal utama kajian ini ialah kepelbagaian penulis (pengarang) telah ditambah kepada model penulisan yang asalnya dilihat sebagai teks pengarang tunggal. Ini membantu pemahaman yang lebih baik dalam menyelesaikan kekangan penyuntingan teks artikel penyelidikan. Selain membina kesedaran, implikasi pedagogi kajian ini termasuk menyediakan prinsip-prinsip pengarangan untuk penyelidik baru, dan beberapa pengajaran untuk pengurusan konflik semasa proses kertas penyelidikan bersama pengarang. Implikasi lain melibatkan cadangan penambahbaikan kandungan bengkel penulisan bagi staf . Selain itu, cadangan untuk amalan profesional dan kajian masa depan mengenai penerbitan penulisan artikel penyelidikan dibincangkan di bab akhir kajian ini.

ACKNOWLEDGEMENT

This gift of God could not be produced without the great help, inspirations, and encouragements of many individuals throughout and before my PhD expedition.

I dedicate this thesis to my two mothers whom I lost during this journey. My biological mother, Soqra, who was the true meaning of love and sacrifice for me. And my adopted mother, Prof. Dr. Hyacinth Gaudart who was a real symbol of a kind woman and a great support for me and my family during my Master's and PhD studies. I am equally indebted to the encouraging words of my late father, Akbar, who showed me the right path and always insisted on pursuing higher education.

I am grateful to my supervisor Prof. Dr. Moses Samuel who helped, encouraged, and inspired me throughout my doctoral studies. Without his expertise this thesis could not take the present form. My sincere thanks goes to the members of committee and the examiners whose comments and suggestions improved this thesis to a great extent.

My brothers and sisters, and friends from all parts of this planet were always the sources of energy and inspiration by their presence and prays. I am thankful to each and every one of them. Special thanks to my Malaysian sister, Zarimah Jamil, who helped me by writing the Malay abstract of this thesis in an academic style.

In particular, my greatest appreciation and humility goes to my loving wife, Elma, and my adorable daughter, Nafas, who made the entire PhD endeavor possible for me through their constant support and enormous patience. I wish you everlasting joy and success.

Table of Content

Abstract iii

Abstrak iv

Acknowledgment v

Chapter 1 Iintroduction

Emerging Issues in Research on Writing and Publishing Research Articles 2

Statement of the Problem 5

Research Objectives 7

Research Questions 7

Conceptual Framework 7

Multiple multidisciplinary authors 9

Writing processes 9

Publishing processes. 9

Theoretical Framework 10

Complexity theory (Larsen-Freeman & Cameron, 2008) 10

Key concepts of complexity theory 11

Rationale for using Larsen-Freeman & Cameron's Complexity (2008). 14

Complex system of composing a text 15

Parameters involved in writing (Grabe & Kaplan, 1997) 16

Rationale for using Grabe & Kaplan's "parameters in writing" (2014) 18

Significance of the Study 18

Operational Definition of Terms 19

Chapter 2 Rview of Related Literature

Introduction....21
Research Article Composition Process....21
Inconsistency in referring to research article. 25
Idea Generation and Conception Process 26
Shapers of Manuscript 27
Research Process 28
Article Writing Process....29
Writing 30
Genres in writing....30
Multimodality of academic text. 32
Non-native Writers....34
Publishing Processes 35
Writing-for-Publication....38
Authorship in Collaborative Writing 39
Multi- & co-authorship....39
Ethics in authorship 42
New Trends in Collaborative Writing....43
Theoretical Considerations 43
Agency theory 44
Complexity theory 45
Elements of complexity theory 46
Change, adaptation, and context 49
Model of parameters involved in writing 51
Methodological Differences in Related Studies....55

Similar Studies in the Field....56

Chapter 3 Methodology

Introduction....59

Research Site....59

Participants....61

Dr. Janie....64

Dr. Nick....65

Prof. Tony....65

Dr. Yang....66

Prof. Zarimah....66

Dr. Harry and Dr. Lee....66

Mr. Ken....66

Preliminary study....67

Research Design....70

Key phases of case study....71

Boundedness of case....71

Data Collection and Data Analysis....72

Instruments and sources....73

Interviews....73

Observations....85

Documents and artifacts....87

Group discussions....87

Data collection and analysis for RQ1....88

Data collection and analysis for RQ2....90

Data collection and analysis for RQ3 91

Data reduction and data analysis 92

Triangulation of Findings and Trustworthiness 93

Chapter 4 Findings

Introduction 97

Overview of the research project in science as a complex system 99

Writing Process, a Main Component of the Complex System (RQ1) 101

Initial conditions of the complex system (draft zero) 102

Two new grants 104

Real-life experience 105

Expertise 107

Hands on, "system commences the activity" (draft one) 120

Materials, the elements of synthesis process 120

XY2 samples, "input to the system" 123

XY2 bulk, element of the synthesis process 124

System shift to characterization (draft two) 124

Scanning images, output components 125

System shift to voltammetry (draft three) 127

Voltammograms, output components 128

Technical problem and process of change 130

First complete draft of research article (draft four) 133

Assembling produced drafts and shaping research article text 134

Co-authors' review of text 135

Authorship issue changes the text 136

Summary of research question one (RQ1) 138
Complex System Transition to Publishing Process (RQ2) 140
Journal selection, an initial condition 141
Journal A 142
Journal B 143
Authorship issues, components of publishing process 144
Mr. Ken, system adaptability 145
Dr. Nick, victim of control parameters 146
Prof Zarimah, system openness 148
Submission process, point of transition 150
Draft four (D4) rejected 152
First re-submission of research article (draft five) 157
Draft five (D5) conditionally accepted by journal B 158
Second re-submission of research article (draft six) 159
Consulting overseas expert 160
Change in synthesis process 161
Genre issue 161
Draft six (D6) returned for final revisions 163
Third re-submission of research article (draft seven) 164
Published research article (draft eight) 164
Summary of research question two (RQ2) 165
Text, Product-Component of Complex System (RQ3) 167
Draft zero (D0), initial formation of research article 168
Two new grants 168

Real-life experiences 169
Expertise 170
Draft one (D1), hands on synthesis of XY2 particles 172
Draft two (D2), characterization of XY2 particles 177
Draft three (D3), voltammetry of XY2 particles 179
Draft four (D4), first complete draft submitted to journal A 182
List of authors 184
Draft four (D4) rejected 186
Draft five (D5), re-submission of article to new journal (journal B) 188
Draft five (D5) accepted conditionally 191
Draft six (D6), article re-submission to journal B 192
Draft seven (D7), final re-submission of article to journal B 194
Draft eight (D8), published research article 197
Summary of research question three (RQ3) 200

Chapter 5 Discussion, Implication, and Conclusion

Introduction 204
Writing Process of Multidisciplinary Multi-Authored Research Article 205
Publishing Process of Multidisciplinary Multi-Authored Research Article 206
Research Article Text as Product-Component of Complex System 207
Implications 207
Pedagogical-practical implications 208
Theoretical implications 212
Complexity theory and text 212
Structured variations and variation within structure 213

Multiplicity of authors and the model of parameters involved in writing.... 217

Big “C” 218

Suggestions for Further Research..... 219

Methodological issue 219

Multidisciplinary research 220

References.....222

APPENDICES 231

List of Tables

Table 1.1 Complexity Theory and Composition of Research Article Text 13

Table 2.1 Major Text-based Studies on Research Articles.....23

Table 2.2 Origins of Complexity Theory.....46

Table 3.1 Researcher-authors' Profile 63

Table 3.2 Tentative Participants of the Study.....68

Table 3.3 Interviews in different stages of this study 75

Table 3.4 Research Questions, Data Collection and Data Analysis Procedures 92

Table 4.1 Research Team's Profile 112

Table 4.2 Researchers' Roles and Contributions 119

Table 4.3 Finalized List of Authors 150

Table 4.4 Energy and matter from outside system..... 157

Table 4.5 Researcher-Authors of Drafts of the Research Article..... 184

Table 4.6 Change in Referencing Style 188

Table 4.7 Citation Style, Different among Journals..... 190

Table 4.8 Text Enrichment by Multiple Authors 191

Table 4.9 Changes to Draft Six (D6) of the article 195

Table 4.10 Headings of the Published Research Article..... 199

Table4.11 Contents of Drafts of the Research Article 202

Table of Figures

Figure 1.1. Conceptual framework of this study 8

Figure 1.2. Some parallel elements of complex systems and research process 14

Figure 1.3. From parameters involved in writing Grabe & Kaplan, 2014, p.215).....17

Figure 2.1 Grabe and Kaplan's parameters involved in writing (1997, p.215).....54

Figure 3.1. Data deduction and emerging themes 89

Figure 4.1. Writing and publishing processes and drafts of research article (D_0-D_8).98

Figure 4.2. Elements of idea generation for research project 103

Figure 4.3. Natural waters of Malaysia 106

Figure 4.4. Characterization equipment 125

Figure 4.5. Voltammetry equipment 128

Figure 4.6. Interconnectivity of components in the complex system of writing and publishing a multi-authored science research article 132

Figure 4.7. Three states of the complex system 136

Figure 4.8. Procedures after submission of RA draft to journal 151

Figure 4.9. Rejection of manuscript by Journal A 153

Figure 4.10. Two major revisions required by journals (according to Dr Nick)..... 153

Figure4.11. Rejection, a nested subsystem within publishing process 156

Figure 4.12. Production of draft six (D6) and the two new samples 163

Figure 4.13. Acknowledgment of the research grants as part of the written text..... 169

Figure 4.14 Real life experience embodied as the written text 170

Figure 4.15. Authors' expertise appear in the research article text 171

Figure 4.16. The materials used in laboratory are given in published research article 173

Figure 4.17. Equipment used in synthesis of XY_2 particles 174

Figure 4.18. Using various terms for one concept by multiple authors 175

Figure 4.19. X-ray patterns of XY_2 particles and bulk in multimodal text 176

Figure 4.20. Details for synthesis of XY_2 particles in form of a table 177

Figure 4.21. XY_2 particles prepared in two methods in characterization process 177

Figure 4.22. Use of symbols in showing the position of electrons in XY_2 particles 178

Figure 4.23. Color-coded voltammograms of XY_2 particles and bulk 180

Figure 4.24. Grabe and Kaplan's parameters involved in writing (1996, p.215) 181

Figure 4.25. Multiple voltammetry of XY_2 type A2 confirms its detecting capacity 181

Figure 4.26.Various concentrations of Z_2 had no effect on detecting capacity of XY_2 182

Figure 4.27. New drawing of symbolic XY_2 crystal formation 183

Figure 4.28. Comments and feedback from Journal A after rejection of manuscript 187

Figure 4.29.Two new samples, C1 & C2, added to the table (compare with figure 4.19) 192

Figure 4.30. Images of the two new XY_2 samples 193

Figure4.31. Addition of the X-ray patterns for the two new samples (C1 and C2) (compare it with Figure 4.18) 194

Figure 4.32.Article's heading for the published article in Journal B 198

Figure 5.1. Interacting sub-systems in different levels and scales (adapted from Eppel, 2009; Larsen-Freeman & Cameron, 2008) 213

List of Appendices

Appendix A Guide for post-observation interview 232

Appendix B Guidelines for Initial Interviews with Each of the Authors 233

Appendix C Observation Protocol Guide for observing the researcher-authors..... 234

Appendix D Diane Larsen-Freeman (personal communication, 2013) 235

Appendix E Informed consent form for participation in research process 236

Appendix F Rejection email from Journal A..... 239

Appendix G Table produced from Synthesis of various XY2 Particles .....

Appendix H Twelve images 243

Appendix I Important content of the very first meeting of the whole research team 244

Appendix J General Interview Questions 245

Appendix K Example of Data Reduction/Analysis for this Study 246

CHAPTER 1 INTRODUCTION

In a research-dominant academic world, writing and publishing research articles (RAs) especially in English-language journals is crucial. To achieve this goal, academics need to be fully aware of the processes involved in writing and publishing research articles. Academic publishing not only involves academics, but research students in postgraduate programs as well. One of the current policies of prestigious universities for improving their global ranking is to require their students to write and publish research articles in order to fulfill their "graduation requirements" (Cho, 2009; Li, 2007). A good example of such requirements is the graduation prerequisite of my PhD candidacy that required me to publish research articles based on the findings of this study which you are reading now.

Today, even the nature of research has changed in academic world. More and more research in sciences as well as social sciences is conducted by researchers from different disciplines cooperating in research teams, groups of researchers writing RAs. As a result, multidisciplinary multi-authored texts have become very important. So the process of writing research articles is mostly a multidisciplinary multi-authored phenomenon now. This has implications for the writing process and multi-authored research articles (RAs).

Existing research on various components of research article writing has extensively discussed issues such as contributors or "shapers" of RA text (Burrough-Boenisch, 2003; Li & Flowerdew, 2007), authorship (Flanagin, Fontanarosa, & DeAngelis, 2002; Welfare & Sackett, 2011), ESL students' difficulties and coping strategies in writing RAs (Cheung, 2010; Okamura, 2006), non-native RA composers (Flowerdew, 1999a, 1999b, 2008), genre analysis of sections of the RA (Hyland &

Tse, 2005; Martın, 2003; Negretti & Kuteeva, 2011) , textual analysis and the process of 'writing up' research articles (Badley, 2009; Cho, 2009; Li & Flowerdew, 2007; Richardson, 2000). One limitation of the existing body of research on writing is that it seems to view academic writing as merely 'writing up' the text. In Badley's words, "it is as if first comes the research, an active creation of new knowledge, and then comes the writing, a relatively passive assembling of what has already been achieved" (2009). Thus, he suggests that, there is a need for researchers to re-describe RA writing "as a more dynamic set of activities and practices" which connect research process and the writing-for-publication process. These are not two 'distinct processes', but a "naturally complex" system of interconnected components (Zamel, 1982).

While research has focused on discrete parts of the RA writing and publishing process, to fully capture the view of this process there was a need to investigate the entire research process of which writing is a crucial part. A holistic investigation of the aspects of research process which impact the research-writing (preparation-publication) process sheds light on complexity of writing research articles.

Emerging Issues in Research on Writing and Publishing Research Articles

There are four major emerging issues in the current research article literature: new trends in the production of multi-authored text and the role of authors; the ethical issues of authorship and multi-authorship; the processes of writing and publishing RAs; and disconnection among research, multi-authors, and writing-for-publication process. These issues are briefly introduced in the following paragraphs.

Apart from the need to look at the research process as a whole, there is another phenomenon that has happened more recently. There is a shift in research from single author to multiple authors and from multiple authors within one institution to multiple

authors around the world. Changes in the research process have impacted the 'writing-up' process and the concept of authorship. Research is conceived in terms of collaborative effort in broad projects, in large scale funding, and multiple authors can have access to more resources (Wray, 2002) than single author. There is a lot more international collaboration in research. The change is not just in methodology, researchers are also changing. Sometimes, multi-authors are multidisciplinary researchers from different institutions in different parts of the world with multiple views of the writing process, and multiple conventions of the writing. They may not be sharing the same assumptions. Tasks given to co-authors and the roles they play throughout the research process are not fixed and may be overlapped, changed, and reassigned (Zutshi, McDonald, & Kalejs, 2012).

On the other hand, new advances in communication technologies such as wikis have changed the reader-writer relationship (Kuteeva, 2011; Lund, 2008); readers are no longer passive viewers of the text. When writing is seen not as just 'writing up' but as integral to the research process, indeed this reader-writer relationship involves reader-writer-researcher relationship. All these, add to the complexity of writing and publishing multi-authored RAs.

Multi-authorship is rewarding in most cases but, it is increasingly becoming more difficult every day to claim authorship/ownership of the text by huge impact of others' voices, thoughts, and contributions on our "own" text (Bakhtin, 2010; Lin, 2003). Unfair authorship and unethical issues (e.g.Geelhoed, Phillips, Fischer, Shpungin, & Gong, 2007; Sandler & Russell, 2005), problems in collaborative research of student-faculty and decision making about authorship arrangement (Geelhoed et al., 2007; Welfare & Sackett, 2011), responsibility over the issues of plagiarism and research misconduct (Erlen, Siminoff, Sereika, & Sutton, 1997;

Macfarlane, 2017), and ambiguity over the use of first person pronouns (Dueñas, 2007; Hyland, 2002) are examples of debated issues in the last two decades or so. Regarding ethical issues, current literature also provides valuable principles and instructions for authors (e.g. the seven principlesCoats, 2009;chapter two).

In existing literature, writing process is considered as writing-up the text, the physical act of writing or composing process. While this is mostly true for simple tasks of writing, which can be conducted in a short period of time mostly in class situation, it may not be the case for authentic task of writing RA. In addition to writing-up research article text, authors need to go through other processes (e.g. submission and revision process, (Belcher, 2007); peer review process, (Gosden, 2003) before their RA text gets published in the journal. These processes work interdependently and influence each other. But, to the best of my knowledge, studies so far did not consider writing/publishing process in conjunction with other processes in "writing-for-publication process" (Cheung, 2010; Cohen, Manion, & Morrison, 2013; Holmes, Hodgson, Nishimura, & Simari, 2009). Therefore, the assumed, untouched, or ignored components of writing and publishing process of RAs need to be re-visited (Badley, 2009) in the way that all contributing processes are viewed as interconnected components of a complex system.

During the last three decades the whole research process is viewed as a complex system of interconnected components (Bereiter & Scardamalia, 2013; Casanave, 2005; Larsen-Freeman & Cameron, 2008; Prior, 2013; Susser, 1994). Yet, only discrete parts of writing and publishing process or different parts of RA text have been investigated in separate studies. In addition, studies on RAs are mostly focused on single-authored texts. Due to the increase in number of multi-authored RAs the need to investigate the production of these texts has become more important. But,

research is still rare in capturing the whole process of writing and publishing multidisciplinary multi-authored RA. This highlights the importance of future research in conducting holistic studies for gaining deeper and broader insights into real-world connections among researching, writing, and publishing process. The present study aims to capture this view by looking at multiple multidisciplinary authors' efforts for writing and publishing research article.

Statement of the Problem

In general, studies of RA writing and publishing process have mostly looked at single dimensions of RA text or separate/single processes: textual analyses such as corpora of RA texts (Ghivirigă, 2012), studies of RA introductions (Cortes, 2013; Fakhri, 2004), frequency of self-mention words (Hyland, 2001), and genre analysis of RA abstracts (Gillaerts & Van de Velde, 2010); and single processes such as cognitive process (Flower & Hayes, 1981; Matsuda, 2003), composition process (Flowerdew, 1999b) , and submission-revision process (Belcher, 2007; Mungra & Webber, 2010; Pifarré & Fisher, 2011). Despite the large number of studies on RAs, there are still underexplored areas. Based on current literature, the present study addresses three main gaps.

Previous studies have viewed writing process of different texts as writing-up the text (e.g. Badley, 2009; de Larios, Manchón, Murphy, & Marín, 2008). This consideration may be true for simple tasks of writing, but for the authentic task of writing RA, writing process needs to be re-visited by looking at three main processes (researching, writing, publishing) working together. But, existing research has not sufficiently addressed writing-researching, writing-publishing, and publishing-researching relationships. Instead, they have mostly been assumed as disconnected processes in which end point of one is the beginning of another.

Current process-oriented studies of writing and publishing RA mostly look at single-authored RAs (e.g. Burrough-Boenisch, 2003; Li & Flowerdew, 2007). In addition, despite a global increase in number of multidisciplinary multi-authored RAs in different disciplines (Brown, Chan, & Chen, 2011; Yarcheski, Mahon, & Yarcheski, 2012), research articles are mainly studied for ethical issues such as contribution allocation, authors' name order (Brown et al., 2011; Floyd, Schroeder, & Finn, 1994), authorial identity/authority (Hyland, 2001; Hyland & Tse, 2012), and unfair authorship (Welfare & Sackett, 2011). Authorship is even more complex today as multiple authors are located in different places (around the globe) using wikis, emails, blogs, live-chat and other forms of communication technologies to discuss/conduct research (e.g. Kuteeva, 2011; Leuf & Cunningham, 2001; Li & Flowerdew, 2007; Liu, 2011; Lund, 2008; Zutshi et al., 2012). Although facilitating, using technologies has added extensive complexity to production of multi-authored texts. The present study is a naturalistic enquiry in following multiple authors almost in all stages of research in order to unveil complexities of research process.

So far, RAs have been treated as "simple narratives of investigations", but in fact "they are complexly distanced reconstructions [and reconnections] of research activities" (Burgoine, Hopkins, Rech, & Zapata, 2011; Swales, 1990, p. 175). The influence of other interdependent components on RA text has not been fully addressed yet. To the best of my knowledge, no research so far has studied the whole process of writing and publishing multidisciplinary multi-authored RA. Such an investigation sets the scene for better analysis of the complex and multidimensional system of writing and publishing multidisciplinary multi-authored RA. The present study contributes to the existing knowledge by holistically looking at different dimensions of writing and publishing processes through the lens of complexity theory.

Research Objectives

By using two frameworks, complexity theory and model of parameters involved in writing, the researcher of the present study tried to look at the entire process of writing and publishing of a multidisciplinary multi-authored research article in science. From this stance the objectives of this study are:

To explore the processes of writing a multidisciplinary multi-authored research article in science by multiple ESL authors

To investigate the process of publishing a multidisciplinary multi-authored research article by multiple ESL authors

To analyze different drafts of research article shaped and reshaped by multiple ESL authors throughout the research process

Research Questions

Based on the objectives, this study aims to investigate the following research questions:

1. How is the process of writing multidisciplinary multi-authored research article carried out by ESL authors?
2. How is the process of publishing multidisciplinary multi-authored research article carried out by ESL authors?
3. How is the text shaped in the process of writing and publishing multidisciplinary multi-authored research article?

Conceptual Framework

The present study is conducted based on several concepts. The main concepts of this study are "writing processes" and "publication processes" of RA text, and

"multiple authors" of the RA text. In this section the concepts and their relationships are discussed and also a visual map of conceptual framework (Figure1.1) for the study is provided.

Figure1.1 provides the conceptual framework for this study. As it is displayed, there were two major processes in the whole research process for writing a research article by multiple authors. Although each process was considered inclusive of its sub-processes, the two major processes were interconnected and interrelated. The researcher-authors' position was at the juncture of all influences made by the whole set of processes. Changes to drafts of the research article, imposed by processes, were made by authors.

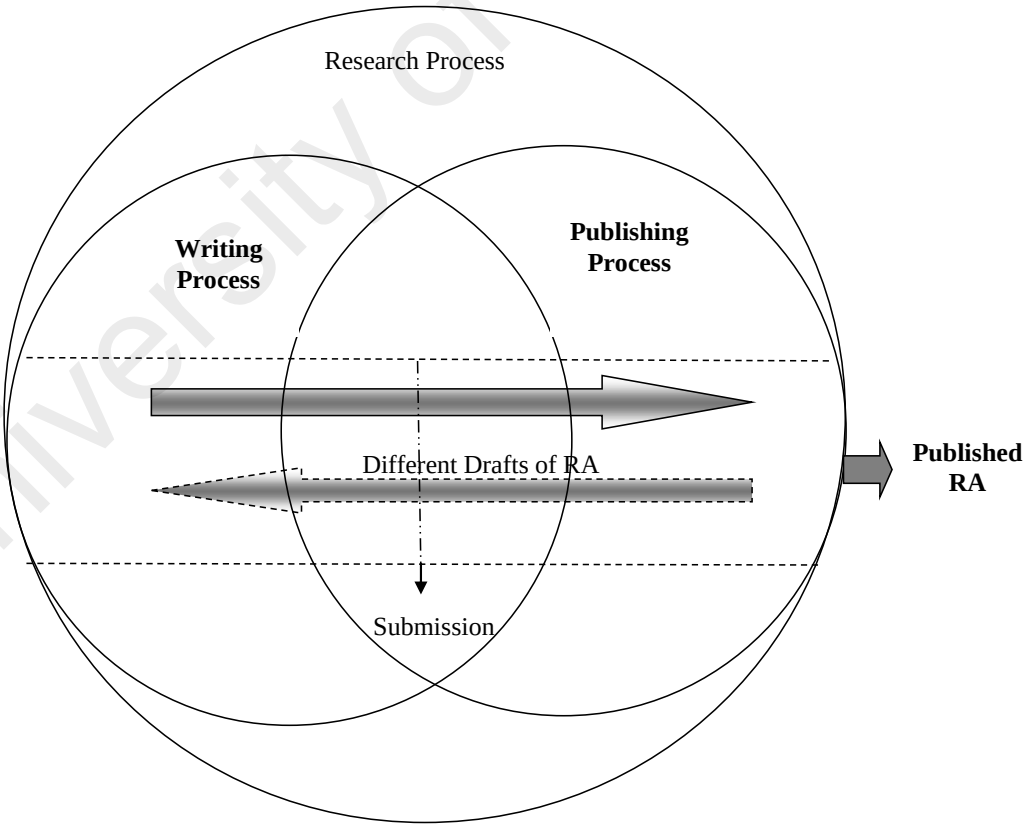

Figure 1.1. Conceptual framework of this study

Multiple multidisciplinary authors. The authors' "roles and responsibilities" (Flanagin et al., 2002) inevitably influenced the writing and publishing processes whether directly or indirectly. Researcher tried to avoid ignoring or assuming (Cameron, Nairn, & Higgins, 2009) those influences. Consequently, new concepts emerged from multiplicity of authors.

Writing processes. Since the participant researcher-authors' ultimate goal was to come up with the "composed RA" text, composition process was considered as the "main process". Other processes served the main process through their direct or indirect influences. In current literature "writing process" (Hyland, 2003; Zamel, 1982) and "writing up" the text (Badley, 2009) are interchangeably considered as "composing process" of the text. Two well-known sub-processes of composition process are "knowledge telling" and "knowledge transforming" processes discussed by Grabe and Kaplan, Grabe and Kaplan (2014, p.124).

Publishing processes. Publishing process and related sub-processes may seem to appear only at the end of research process where the complete RA text was ready for submission to the target journal (Badley, 2009). But, literature also confirms that there are processes after submission. An example of sub-process in publication is the review process conducted by colleagues, peers, and journal editors (Mungra & Webber, 2010). Hence, publication processes include several sub-processes too.

Although existing literature is abundant with studies of separate/single components of research article writing and publishing process, this process has not been examined as a complex system in which interconnected components influence each other to achieve their shared goal, getting the research article published. From this view point the research article text was exposed to change by direct or indirect

influence of every single component. Thus, the complex system of writing and publishing a multidisciplinary multi-authored research article in science required further investigation.

Theoretical Framework

To analyze the findings in the present study, researcher used two frameworks. Larsen-Freeman & Cameron's "complexity theory" (2008) and Grabe & Kaplan's model of "parameters involved in writing" (2014). The features of each framework and the way they served this study are elaborately explained in the following sections.

Complexity theory (Larsen-Freeman & Cameron, 2008). In 1997, Diane Larsen-Freeman introduced a new application of complexity theory for research in language acquisition and linguistics. She also provided the elements of complexity theory in that study. However, she concluded that it was "too early" to claim whether complexity theory could describe second language acquisition. Interestingly, almost a decade later (2008), in Diane's co-authored book with Lynne Cameron, "Complex Systems and Applied Linguistics", language is confidently considered as "complex adaptive system". Since linguists deal with languages as "complex, adaptive and dynamic systems", complexity theory provides us a new vision in looking at applied linguistics subject matters (Larsen-Freeman & Cameron, 2008, p.229).

Complexity theory is a general theory of complex systems. In this theory Larsen-Freeman & Cameron (2008) refer to the composing process as a case of a complex system. They state:

This compositional system contains multiple interacting subsystems. Composing in the moment arises through the meshing together of systems and subsystems working at various levels and timescales (p.187). [This theory explains]

how the interacting parts of a complex system give rise to the system's collective behavior and how such a system simultaneously interacts with its environment (p.1).

To publish a research article in a journal, researchers need to be engaged in a research process in which sub-processes such as writing process and publishing process interact interdependently. The present study viewed the whole research process, including its components and sub-processes, as a complex dynamic system (D. Larsen-Freeman, personal communication, May 5, 2013: see Appendix D). Therefore, this study leans on complexity theory, a recent development of chaos-complexity theory which appeared originally in biology, chemistry, economics and physics (Mason, 2009).

Larsen-Freeman and Cameron (2008) explained that, biologist Conrad Waddington was the main figure who influenced the development of the concept of complexity theory in 1940 (p. 2). The theory came to existence mostly from biology, mathematics and physics. During the past twenty years, researchers in other disciplines such as business management, economics, psychology, and linguistics adapted and applied the theory (pp.4-5). In most cases the theory was localized by researchers for their own discipline (see chapter 2 for more historical back ground).

Key concepts of complexity theory. Larsen-Freeman (1997) provided the features of complex systems as: *dynamic*, i.e. they change over the time; *complex*, i.e. they have large quantities of components or agents interacting interdependently; *nonlinear,* i.e. their components do not follow the law of cause and effect; *unpredictable,* i.e. they include never-repeating patterns as new stages emerge from constant changes to the whole system; *sensitive to initial conditions,* i.e. they display unpredictable behaviors depending on the initial stimulus; *open,* i.e. they embrace new

matter and energy from outside without losing their stability; *adaptive,* i.e. they openly absorb changes to take place and fit into the whole system; *self-organizing,* i.e. they display new behavior after each change; *feedback sensitive,* i.e. based on their dynamic nature, they react to feedbacks received from within or outside of the system; having *fractal shape*, complex systems may have a predictable panoramic pattern (like a tree), but each component has its own unique shape and behavior (branches of a tree).

Complexity theory deals with interconnected dynamic systems, in which components and agents are exposed to continual change. This change results in adaptation of the whole system. In a system, context is not an entity outside or separate from the whole. Context is an inborn part of the system and is interrelated with each sub-system alone as well as with the entire system. The information about the system automatically includes information about the context as well (Larsen-Freeman & Cameron, 2008, p. 16).

In defining complexity theory the term "complex" is not simply and merely equal to complicated. Since the entire system is not bigger than "the sum of its parts" it is appropriate to view a system holistically (Larsen-Freeman & Cameron, 2008; Morrison*, 2005). In other words, actions and interactions of components build the behavior of the whole system. Thus, examining each component separately only gives us insight about that component. It cannot help with understanding of the whole system (Larsen-Freeman, 1997). Because "getting a scholarly article published is a complex process" (Cheung, 2010), the present study, holistically, looked at the complex system of writing and publishing RA by multiple ESL authors.

To analyze the behavior of a complex system, each component and agent within system(s) can be the focal point of the study, having other components as its

environment. The focal aspect influences its environment and is influenced by its environment too. These interdependent components and agents and their interactions at different levels and timescales shape the holistic behavior of the dynamic complex system. Table 1.1 provides some of the major elements of complexity theory and key concepts for writing and publishing research articles.

Table 1.1

Complexity Theory and Composition of Research Article Text

Elements of Complexity Theory	**Concepts in composition of research articles in science**	**Comments**
Components	Act of composing the text, laboratory data, discussions, feedbacks from journal editors, etc.	Each part and element of research process is considered a component
Agents	Authors, reviewers, etc.	All individuals are agents of this system
Material/Physical Elements	Materials, machinery, computer, pen, etc.	The elements which help authors in the processes of research, writing, publishing, and other sub-processes
Levels/Types of Change	Change in different components	Every single change in components which triggers influence on other aspects
Trajectories	Behavior of system and sub-systems (process/sub-processes)	e.g. submission and resubmission to journal, generating new drafts of RA, all interactions in general
Fixed point attractor	Submitted article/ Published article	No change or specific behavior is expected or observed

Rationale for using Larsen-Freeman & Cameron's Complexity (2008). The process of writing and publishing research articles was a complex system in which agents and components acted and interacted interdependently by influencing each other and in a bigger picture influencing the whole research process as complex system. For instance, multidisciplinary researcher-authors were the main agents of this system. Their experiments in laboratory, discussion sessions, composition of RA drafts, and other components influenced the writing process. Figure 1.2 displays some of the elements of the complex system of writing and publishing multidisciplinary multi-authored research article in science.

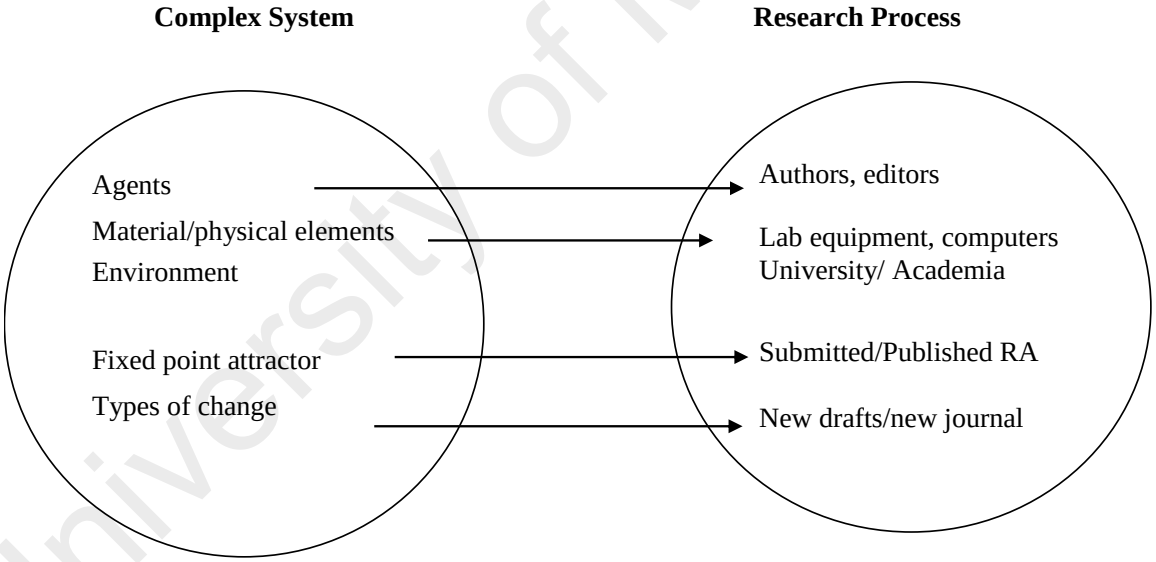

Figure 1.2. Some parallel elements of complex systems and research process

About the influences of components on each other and holistically on the complex system, research question one (RQ1) captured the "how" and "what" of these influences. A phase transition (Larsen-Freeman & Cameron, 2008, p.187) took place in the system when the researcher-authors submitted the first final draft to their first

target journal (Journal A) and it continued until the RA text was published in the second target journal (Journal B).

Research question two (RQ2) looked at this phase and how it was related to the previous phase and in general to the whole process. By looking at different parts of the research process this study tried to investigate how the interactions of those parts shaped the new patterns and behavior of the process as complex system. Since the product of writing and publishing processes was the published RA, the text was considered as the main behavior or output of this complex system (RQ3).

Complex system of composing a text. Within every complex system components and agents are linked through multiple interrelations. Multiple systems and sub-systems interact interdependently in the dynamic process of "producing a written text" (Larsen-Freeman & Cameron, 2008, p.187). In production of a RA, processes represent the trajectory of a complex system. When the first final draft was submitted to journal, from complexity theory perspective, the system had reached a "fixed point attractor" (p.187), where no more changes took place in the system. In the present study multiple authors and sub-processes of the whole research process were the components of a complex system. Since this was an open system, new agents and components entered the system during the writing and publishing process.

Complexity theory explains the important characteristics of complex systems, non-linear systems which are dynamically self-organized and open. They are emergent, adaptive and sometimes chaotic as well. Complexity theory has the potential to add to our knowledge about different aspects of language including composition of written texts (Larsen-Freeman, 1997). Drawing on complexity theory, this study illuminated the process of writing and publishing research article as a

complex dynamic system (Cheung, 2010). In order to understand the operation of this system and its components, researcher needed to capture the influence of each component and observe the interactions between and among components within the system (Larsen-Freeman and Cameron, 2008). This was possible by applying a naturalistic approach, in which researcher followed the authors in every possible stage to see the real-life world of writing-for-publication of a multidisciplinary multi-authored research article.

Through the lens of complexity theory, although the general (fractal shape of) process and final product (research article text) could possibly be predicted, the sub-processes and components of the system and their relationships could never be fully predicted in the processes of writing and publishing the multidisciplinary multi-authored RA.

Parameters involved in writing (Grabe & Kaplan, 1997). Since complexity theory provides a general view of the whole process of writing and publishing a multidisciplinary multi-authored research article and the components of this system, for better and deeper understanding of the text which was shaped and re-shaped in production of drafts of RA, for analysis of the findings Grabe & Kaplan's model was used as well. The concepts involved in this model represented the necessary elements and components for production of the RA text.

To complement Larsen-Freeman & Cameron's Complexity Theory, Grabe and Kaplan's model of Parameters Involved in Writing served the analysis of findings. This model identified the key parameters involved in writing by locating the basic question of : "*Who writes what to whom, for what purpose, why, when, where, and how?"* (Grabe & Kaplan, 2014, p.203). By posing this question and linking the

answers to each part of the question, in Figure 1.3, Grabe & Kaplan (2014) have provided a closer view of the writing process and the written product. This model explains how certain constraints shape the text and its relevant aspects.

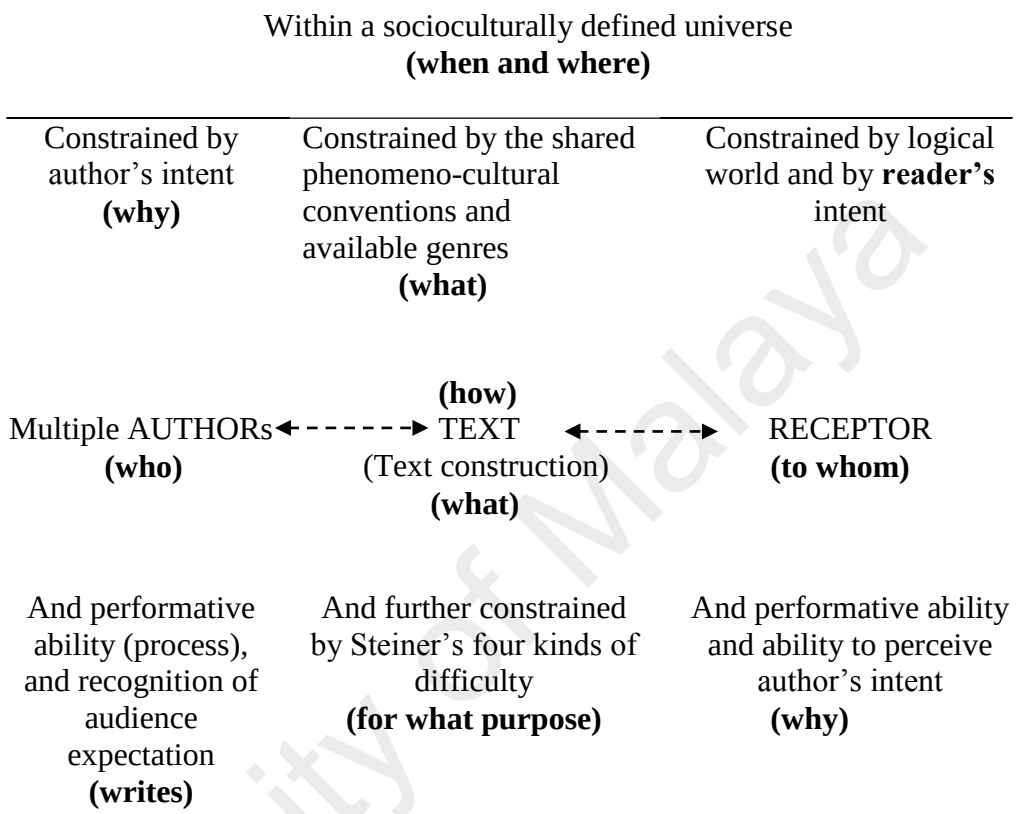

Figure 1.3. From parameters involved in writing by Grabe & Kaplan, 2014, p.215)

In Grabe and Kaplan's model of parameters involved in writing, there are three components namely author, text, and receptor. In the present study this model is adapted and modified in the way that it suits the multiplicity of the text. Hence in Figure 1.3 instead of author you see "authors". The multiple authors of the research article were several sub-components within the component of author in the model. My contribution to the model was adding the term "multiple" before "author". This will change the concept of authorship, and the relationships among authors, text, and receptor. In addition, a theoretical contribution of the present study is adding a plural "s" (to Author; the model of parameters involved in writing) to emphasize on the role

that multiple authors play in production of an authentic text, research article. In the present study each researcher-author had his/her own contribution to the text and consequently on their audience, journal reviewers and readers of the published article.

Rationale for using Grabe & Kaplan's "parameters in writing" (2014). Here is an example which provides the rationale for using Grabe and Kaplan's (2014) model of parameters involved in writing for the present study. The answer to the question of "*to whom* (RECEPTOR) the writers (AUTHOR) wrote the article (TEXT)?" was the journal editors and ultimately the readers of the journal. It required understanding and following the journal's scope for shaping the text and setting the whole process in direction of a satisfactory research. There were other initial considerations before conducting research. I tried to understand and report how and to what extent the audience, *to whom* multi-authors wrote, influenced the whole research process in general and specifically the text.

Significance of the Study

The findings of the present study contributed to both theoretical and pedagogical aspects of writing and publishing research articles.

1- This study captured the actual processes through which the drafts of RA were shaped and re-shaped by multiple ESL authors in science. Exploration of processes helped in awareness making for academics and writing instructors towards RA writing and publishing processes as a sub-genre of academic writing.

2- The contextual contribution of the present study was the multiplicity of authors. This is beneficial to researchers who want to co-author research articles with other academics. Besides, this study illuminated the division of labor among multiple authors and the influences each of them had on shaping and re-shaping

of drafts of RA whether directly or indirectly by applying a naturalistic-holistic approach.

Operational Definition of Terms

Research Article (RA): First, in order to follow the trend in the existing literature the terms "research article" and "RA" are used interchangeably throughout the present thesis. To Swales (1990, p.93) RA is "an end product that has been specifically shaped and negotiated in the author's efforts to obtain acceptance" by the journal and its readers. But in the present study all drafts of the research article which were produced by the participant researcher-authors, in different stages of research process, were named as drafts of research article.

Researcher-Author: To most journals and readers of articles, the individuals whose names appear on the top of the paper, immediately under the title, are considered as the authors or owners of that paper. A better representative for definition of author can be "researcher-author". In this study the terms "author" and "researcher-author" were used interchangeably to address the participant researchers who contributed to different parts of the research project such as data collection, data analysis, and writing of the drafts of research article as well. Since their names appeared on the top of the research article as the owners/authors of the text, they were responsible for the published RA. For this reason and in order to protect the authors' intellectual property, in the present thesis the authors' names and the materials that were used in their research project were replaced by pseudonyms.

Researcher: In this manuscript, that you are reading it now, the term "researcher" mostly refers to the conductor of the present study who has tried to avoid using the terms "I", "me", or "my" in the thesis.

Writing Process: The process through which several drafts of RA were shaped. Based on many factors such as research activities and researching style/style of the research team there were several drafts written throughout the whole research process.

Publication/Publishing Process: Despite this process started from the very beginning of the research project, in the present thesis the data for publishing process was analyzed and presented after the writing process was completed and the research team submitted the first complete draft of the research article to their first target journal, Journal A.

Research Process: A process that researcher-authors conducted research for a specific purpose; in the present study the specific purpose and ultimate goal of multiple authors (researchers) for doing research was to publish the research article (RA).

Writing-researching relationship: The influence(s) of research process on writing process and vice versa.

Publishing-researching relationship: The influence(s) of research process on publishing process and vice versa.

Writing-publishing relationship: The influence(s) of writing process on publishing process and vice versa.

CHAPTER 2 REVIEW OF RELATED LITERATURE

Introduction

Research article (RA) writing and the components of research article, have long been among primary research areas in academic writing research (e.g. Flower & Hayes, 1981; Flowerdew, 1999a, 1999b). Existing literature is replete with studies of various aspects of RA, including genre analysis of different sections of RAs (e.g. abstracts, introductions, and discussion), editorial processes, and the shaping processes in writing of a RA. These efforts are critically discussed in this chapter.

Research article, as a writing product, is considerably significant today, due to the increasing emphasis on publication. Research article publication also has high potential in building up reputation for academics in research-dominant world. The present study took advantage of this vast research era by looking at the whole process of writing and publishing RA by multidisciplinary ESL authors in science. In this chapter the related literature is discussed according to the relevant areas of research including writing and publishing process (of RAs), authorship and multiple authors, and the research article text. Several other studies are also discussed in the following pages according to similarities to/differences from the present study.

Research Article Composition Process

Literature on writing research articles covers a variety of subjects. The studies were mainly based on textual analysis of RA and its various sections. Where process is considered, researchers report a workshop on writing and publishing processes (Barker, 2011a, 2011b, 2011c; Burgoine et al., 2011), provide six practical steps for novices to write their first journal article (Driscoll & Aquilina, 2011), or support the importance of process and process approaches in teaching writing (Susser, 1994;

Zamel, 1982). These studies were reported in conceptual or theoretical articles. But, very few researchers paid attention to the "process of writing RA" (e.g. Li, 2006; Li, 2007); it is almost an untapped issue.

Various aspects and sections of the RA text, broadly called IMRAD (introduction, methods, results and discussion), have received extensive attention. For instance, RA abstracts, lexical bundles in RA introductions, and the use of pronouns and determiners in the writing of RA text (Cortes, 2013; Hyland, 2001, 2002; Martın, 2003; Samraj, 2005) were the focus of researchers.

In the present study "RA writing process" is used as a blanket term equal to the whole "research process". Besides, the process of "writing up" the RA text is named "composing / composition process" which refers to the physical act of writing. This aspect of writing process (writing up) has been widely studied and, usually, the research focus was on single writing tasks.

Literature on writing research article covers a variety of subjects. Generally, these studies are mainly text-based rather than process-based. Where process is considered, researchers report a workshop on writing and publishing processes (in a series of 3 articles: Barker, 2011a; Burgoine et al., 2011), provide six practical steps for novices to write their first journal article (Driscoll & Aquilina, 2011), or support the importance of process and process approaches as equal to the product (Susser, 1994) in conceptual or theoretical articles. Table 2.1 provides some text-based studies.

Table 2.1

Major Text-based Studies on Research Articles

Type of Study/Author(s)	Sources of Data	Focus
Corpus study: Hyland & Tse (2005)	465 RA abstracts	evaluative *"that"* is widely used in abstracts
Corpus &qualitative: Hyland (2001)	240 RAs+ interviews with academicians	author(s)' self-citation & self-mentions
Corpus,Contrastive analysis: Martin (2003)	160 RA abstracts:80 English,80 Spanish	structural units in RAs in two languages
Corpus :Koyalan & Mumford (2011)	9 RAs:44,500 words	Changes to RAs in terms of register
Document analysis: Fakhri (2004)	28 RAs introductions	Rhetorical properties of introductions

Very few researchers, like (Li, 2006), have paid specific attention to the "process of writing RA". Li looked at the progression process of the text by having access both to the student's process logs and to the developing text. She also guided the student participant during the research process by providing him with some sources to study. The student was asked to follow the guidelines for writing a better research article. The peers also had access to the blog and provided their feedback for him. Although, Li's research was similar to the present study in looking at the process of writing a research article, there are still several aspects of RA writing and publishing process that have not been investigated yet. Besides, multiplicity of authors had made this process more interesting and, no doubt, more complex.

Studies on research article writing process are mainly on single processes analyzed separately. Literature in this area can be divided into two categories. First group of studies focused on the processes within researching process such as composition process, editorial process, publishing and review processes (Cheung,

2010; Flowerdew, 1999a, 1999b; Li & Flowerdew, 2007). These processes are not viewed as in conjunction with other components of RA writing process.

Another group of studies whether report a workshop on writing and publishing processes or provide practical steps for novices to write their first journal article or highlight the importance of process approaches in teaching writing (Barker, 2011a; Burgoine et al., 2011; Driscoll & Aquilina, 2011; Susser, 1994). For instance, Cuthbert, Spark, and Burke (2009) benefitted from writing groups in their study and encouraged research-based writing for publication by setting a program for graduate students in Humanities, Arts and Social Sciences. These works are helpful in the sense of awareness making towards the process of writing for publication. But, such studies do not seem to fully capture the holistic picture of RA writing and publishing process, as a "naturally complex" system of interconnected components (Zamel, 1982).

Novice writers who planned to overcome mystified "barriers and pressures" (Keen, 2007) on the way to succeeding writing and publishing RAs need to spare more attention, time, and effort. Cuthbert and Spark (2008) reflected the outcomes of a supportive program for graduate students to write for publication. The program encouraged novice researchers to establish writing groups in order to improve publication and research writing through emphasizing on the "role" that the writing groups play in developing skills for publication. The program helped students demystify research article writing and publishing process and to become aware of the audience they were going to write for, and to acknowledge the supports and the pressures that the writing groups and publication provide for them.

Creswell (2007) clearly indicates "the steps in the process of research" (p.67). A research article needs to pass through three main processes to be a satisfactory text for its author(s) to submit for publication:

- Idea generation (conception) process
- composing process
- publication process

Creswell's idea of considering these steps in conducting research supports the present study in the sense that studying the process of RA writing is not merely equal to studying RA composing process.

According to literature each of the above categories includes several sub-processes within them. The term "process" is defined as ''the interaction of random events upon a configuration of constraints that results in nonrandom but indeterminate outcome'' (Ulanowicz, 2009, p.29 cited in Grassie, 2012).

Inconsistency in referring to research article. In the existing literature, the term research "article" (or "RA") has been used widely (Burrough-Boenisch, 2003; Flowerdew, 1999a, 1999b, 2008; Li, 2006; Okamura, 2006; Swales, 1990). But, there are also other terms addressing RA such as research "paper" (John, 1987; Tardy, 2005; Uzuner, 2008), research "manuscript" (Hernon & Schwartz, 2007), "journal paper" (Cho, 2009), "journal article" (Cheung, 2010), "academic article" (Cheng, 2011), and so on. Regardless of terminology, all these terms refer to the reporting of findings and results of research process. The present study used the term "research article" (or RA) to address an article which was the product of a research process conducted by a team of multidisciplinary researcher-authors.

Idea Generation and Conception Process

Construction of a research article starts from "the researcher's eye" and continues to the point where the article is published in a journal; from conception to publication. The entire researching process seems hard to be broken into smaller and separate processes, but there is a possibility to consider two main stages for writing processes. One is writing process up to the submission of article to a journal. The other includes subsequent processes (Swales, 1990, p.117). To Ken Hyland writing process includes a combination of various components "of which cognition is only one" (2003).

Badley (2009) states that "I prefer to see academic or research writing as a constructive and creative process of learning or transforming what we know, whereas 'writing-up' sounds more like an unconstructive and uncreative claim to be stating what we already know". Composing process starts even before the physical act of writing, when writer reads others' texts to practice shaping his/her own text (Badley, 2009; Driscoll & Aquilina, 2011).

Besides, writing-up a single text in the context of a class by a student to fulfill his/her writing task cannot be simply considered as similar to the authentic task of writing a research article. This study tries to capture the influences all components have on the writing of a RA by multiple authors.

Even the multiplicity of the authors implies the fact that a multi-authored text, made up of several thoughts and processes, is shaped differently from a single-authored text. There are plenty of processes nested within processes. Even before beginning the composition of text "idea generation [which] is a sub-process of planning" (Flower & Hayes, 1981) is already commenced. The ideas and roles played by multiple authors in the process of writing a RA, their cross interactions and

discussions, and other processes helped me capture the knowledge construction process.

Since others' voices and the discourse they use for interaction help us generate our ideas, it is not fair to possess their words unless we fully understand all the senses within the concept and become able to transfer the idea through our own words (Bakhtin, 2010). Therefore, even a single author of a research article cannot claim that he/she is "the only author". In the present study, in which multiple authors worked together and shared their ideas and writing styles, the final draft of the RA was actually multi-constructed (instead of co-constructed) by multiple authors of the research team.

Shapers of Manuscript

Investigations on research articles have mainly noticed the textual aspects, composing process, and the individuals who "write up" or "compose" the RA text (Badley, 2009; Flowerdew, 1999a, 1999b; Koyalan & Mumford, 2011; Li, 2006; Matsuda, 2003). Other shapers of the text (Burrough-Boenisch, 2003), components of knowledge construction process, and other sub-processes are mostly whether assumed or ignored in the existing literature (Cameron et al., 2009).

Costino & Hyon (2011) declared that novice writers' texts shape, and are reshaped by, "informational structures" (abstract, introduction, results, and discussion) of academic texts such as a research article. For instance, "citation practices" of students are believed to be shaped within the academic contexts by considering the constitutions of the said context.

Researchers have yet gone far beyond physical aspects of, and processes in, academic writing. Cameron et al. (2009) have gone into social and psychological aspects of writing, which are considerably dealing with the writer rather than context,

by suggesting emotions as one of the three main (and the only) aspects of writing process. The authors of the study claimed that they could capture most of the irritations and emotions which affect the writing process of L2 novice writers in a workshop on challenges of writing. To the participants of their study "self-doubt, insecurity, lack of skills or confidence, and pressure of other people's expectations" were some of the emotional challenges they had for writing in academic contexts.

By looking at Cameron et al.'s (2009) study two issues are highlighted. One is that most studies, seemingly, tend to minimize or underestimate the process of writing and limit it to only some aspects. The three mentioned aspects of writing maybe among important aspects in writing, but they are not to be claimed as representative of all aspects in academic writing. Secondly, this study approves that even emotional aspects of writing can influence the writing process and the text respectively. Authors, as human beings who have emotions, have to deal with emotional aspects of writing throughout the research process; the process which is under the influence of various components within itself, including the authors' emotions.

Research Process

Creswell (2008) declares that to conduct a research systematically, researchers should follow certain steps. "Research is a process of steps used to collect and analyze information to increase our understanding of a topic or issue" (p.3). The steps in process of research are (p.7):

1- Identifying a research problem

2- Reviewing the literature

3- Specifying a purpose for research

4- Collecting data

5- Analyzing and interpreting the data

6- Reporting and evaluating research

Article Writing Process

Badley (2009) discusses different approaches toward academic writing. He provides four different views on writing-up academic texts. First he argues that writing up is not an add-on to the research process. Separating research process from writing process does not seem very accurate. Second, the "writer-researcher" cannot be considered objective and neutral in the whole process of research. His/her presence in research site influences the writing process too. Third, the idea of writing-up as an uncreative process is rejected in the sense that the writer's creativity and the writer's mind are cognitively interfered with the text. No two writers can write the same research articles from the same research findings. Lastly, Badley indicates that besides the need for critical thinking to write academic texts such as RAs, the task is also a delightful task. It is not only writing-up but writing as a very complex task.

Because the nature of university research is changing, the writing process is also changing apparently. The change is not just in methodology, researchers are also changing. More trans-disciplinary works, more inter-institutional collaboration, more collaboration of cross-national boundaries, in a really globalized world, all made possible by technology. Emails, electronic copies, wiki users who collaborate on writing all shape the new face of writing. The shift has been from single author to multiple authors. And the shift has been from multiple authors within one institution or discipline to multidisciplinary authors around the world in different places.

Writing

Writing is a way of communication or self-expression which, by following certain rules, makes the subject public. The interaction in this type of communication is naturally both "interpersonal" and "intrapersonal". The writer learns through writing and producing the text. He learns through discovering the meaning (intrapersonal) and later sharing the meaning with others (interpersonal). The product of this mainly private act is the text that becomes public at the end (Gere, 1985; Murray, 1999; Samuel, 2005). The terms "composing process" and "writing process" have been used interchangeably in the literature.

Zamel (1982) refers to the process of composing the text which is more effective for teaching writing. She knows writing as a process that helps meaning to be constructed. To Flower and Hayes (1981), in the process of writing "as we write" knowledge is constructed and developed too.

Scholars have contradictory opinions about writing. While Barker (2011a) asserts "writing is possible and even the most inexperienced writers can find some way of getting their ideas 'out there' ", Vanderberg & Swanson (2007) declare that "Writing is a difficult skill to master because many cognitive abilities are utilized during the writing process". Elsewhere, Pifarré and Fisher (2011) illustrated writing as a "complex endeavor" which requires the harmonization of "secretarial and compositional skills".

Genres in writing. Research article is among academic texts and it serves a unique genre. Swales (1990) "Genre Analysis" offers a chapter on research articles. In the opening paragraph he mentions "like all living genres, the RA is continually evolving, and future developments may find part of their explanations in present or previous rhetorical practice" (p. 110).

Although research on writing is replete with the process of writing various texts, it is surprising that plenty of them equalize writing process and composing process. These two may sound the same in the first glance, but the literature on writing process generally has focused on composing process. Not all writing process is equal to composing process while composing process must necessarily be included within writing process. Badley (2009) asserts that research article writing is incorrectly viewed as "writing up". He also claims that researching process is not separated from writing process. In fact, writing process is a process within researching process; they occur simultaneously, "shape and re-shape" each other.

Another study even has gone further from the actual meaning of writing process. Cameron et al. (2009) believe that writing only has three aspects, "emotions, know-how, and identity" and they believe that it would be sufficient to fully understand the writing process if the students get to know these three aspects. They believe that by knowing these three aspects novice writers would be able to master academic writing.

Li (2007) in her study started collecting the process logs from the participant student "after laboratory research and just before he began writing". Despite the fact that, Li's study seems quite similar to my study it describes how researchers so far have seen the process of writing. As if there is a beginning point and end point to the RA writing.

Here, again, I should highlight that conducting the authentic task of writing a research article is different from and more complicated than writing for fulfilling a course work task. Its authenticity is not against being joyful. Even writing RAs can be a delightful (Badley, 2009) task if the writing is considered as a creative process in

which the writer uses his/her creativity. And again by pinpointing this view of separation of research process from writing process in RA writing process by Li (2007) who said " after Yuan had completed his laboratory research" (p.60) the gap in theory of writing process of RAs or misunderstanding towards becomes clearer.

Although writing process and research process seem to be two different processes, we should not forget that the writing process of a research article is a unique process, in continuous interaction with other processes in the researching process. In other word, writing process of RA is within the researching process, not after it is completed.

Li (2007) interfered with the process of composing the RA text by providing some sources for the participant student to write the "Results and Discussion" section. Where the student could choose any other way and the whole process and, consequently the text could be different if he did not receive any advice or help from the researcher. She also mentioned that the "process of writing an article is a continuous process of argumentation". But she pointed out this when her participant student was in the process of writing the RA and for them the research process was over then.

Multimodality of academic text. Science research article is multimodal in nature, as this type of text is mostly replete with graphs, images, formulations, equations, charts, and tables along with the written text. The writers of multimodal texts do the meaning-making through "combination of visual and verbal communication" (Royce, 2002). For instance in science research articles various characteristics of materials are the visually-presented graphs which are "interpreted by

reference to the visuals" (Carter-Thomas & Rowley-Jolivet, 2003) using the verbal type of communication.

Analyzing scientific conference presentations, Carter-Thomas and Rowley-Jolivet (2003) looked at the "visual channel of communication" in multimodality of scientific papers. In their regard, scientific presentation of present day is impossible without using different modes of presentation.

Writing in innovative forms with new uses in dominantly "digital media" (Bezemer & Kress, 2008) has changed the face of text from a merely verbal communication to a mixture of verbal and visual materials. The more new technologies, especially computer-based developments, are available to the writers and readers of text, the more complex and multimodal the text would be shaped.

Screens, indeed, paly the central role now "in public communications and increasingly in educational settings, changing the ways" writers communicate with the readers (Bearne, 2009). With the rise of on-line journals and magazines, articles from all kinds would be accessible easier, faster, and in newer forms and modes.

Today, voice, animations, and hyperlinks have become part of the text which is no longer a mere juxtaposition of a number of words. Both writers and readers prefer multimodal text which helps them in conveying and also understanding the meaning much better and easier than before. In contrast, (Macken-Horarik, 2004) believes that it is getting more challenging for "discourse analysts", who are used to analyze monomodal "verbal text" by default, to examine todays' multimodal text.

Non-native Writers

Among the works of John Flowerdew from 1999 to 2009 the issue of NNESs' writing for publication stands out. In 1999, Flowerdew asserted that English language was "becoming increasingly dominant" language in academic world. But in the same paper, Flowerdew (1999a, citing Crystal, 1998 and Graddol, 1997) confessed that English had already become the ruling language in so many areas of knowledge including education. In 2009 Flowerdew, admittedly emphasized that NNESs are encouraged to write more in English as "the language of international scholarship". This indicates that in a fast-paced period of change, over ten years, English has been quite successful in overcoming other languages to become the dominant language in RA publication and in producing new knowledge to serve academics around the globe.

In the following, a critical review of Flower dew's and Li's (his colleague) works on writing for publication by non-native speakers of English is provided. All of these studies, except one review article, published in 2008, were conducted in Chinese NNES contexts of Hong Kong (Flowerdew, 1999a, 1999b; Flowerdew & Li, 2009) or Mainland China (Li & Flowerdew, 2007, 2009).

Li and Flowerdew (2007) view the process of writing a research article as a process of forming and shaping the RA text. In this article they also provided a list of the most common comments given by journal editors to display the changes NNES writings needed to be fit into the international language of publication, English. Again to emphasize the shaping process of the non-native English speakers' manuscript Li and Flowerdew mention the four correctors of the text as its shapers. "Supervisors, peers, language professionals, and editorial services" are the correctors of novice NNES' writing for publication.

Some recent studies on writing and publishing process of RA have applied the term "demystify" or "demystification" (Burgoine et al., 2011; Cameron et al., 2009; Cuthbert & Spark, 2008) , as equal to *discover, uncover*, and *clarify*. They argue that the assumed, untouched, or ignored aspects of writing and publishing process of RAs need to be re-described (Badley, 2009) by demystification of the processes involved.

Publishing Processes

Burgoine et al. (2011) believe that their workshop conducted on writing and publishing processes could encourage ("postgraduate") students to recognize "that publishing is a process rather than a single event".

Driscoll and Aquilina (2011) suggested "*a practical six step approach*" in writing for publication. They claimed that they were providing these steps as landmarks en route to publishing one's first journal article.

Step 1: read to write

The new authors need to know about the general accepted styles and standards established differently by different journals. Each journal has its own specific requirements for publishing research articles. So, it is inevitable for authors to read as many articles as they can from their target journal to know about the accepted genres and styles of writing. They need to read in order to produce a well-structured research article. Besides, by knowing about the accepted genres of various journals, you will know about the audience or individuals who will read your article. Almost every journal has a section on guidelines for authors. This will clarify the target audience of the journal.

Step 2: target your journal

By becoming familiar with different writing styles found in journals now it is time to select the suitable journal you plan to write for. But as a "first time writer" it is suggested that you better start writing smaller portions rather than a complete research article. You may decide to write a book review, a report on a conference you recently attended, or even an opinion letter or a letter to editor of the journal. These are the smaller and perhaps easier writing pieces that are recommended for new writers to start with.

Step 3: plan what you want to say

You still need to be patient about writing the actual article. Since it can save your time, planning what to write is almost more important than writing itself. Writers who search their topic in the existing literature benefit from coming across relevant theoretical frameworks and discovering possible gaps in knowledge. Identifying the expectations or template of your aimed journal is also part of the planning stage.

Step4: contact the journal

Obviously, the journal editors accept the articles which are well written and have the potential to attract the readers' attention and satisfy their interests. Therefore, the submitted paper must be within the journal scope. It is an advantage for the author(s) to informally contact editorial team in order to fully understand their expectations. Even sometimes getting rejected by a journal editor is not necessarily the result of a bad writing. Late submission or overlapping an earlier submitted similar work may end in rejection. Even if you may not arrange your time schedule to submit the paper on the promised date the contacted editor must be informed in advance to prevent any misunderstandings or rough judgments. Having contact with, at least, one of editors of the journal can help you prevent many of these unfortunates.

Step 5: set the journal as your template

Structure your article based on the template provided by the journal. While you are on the right track of the target journal, there is no reason to risk and try other frames or templates. For instance, guidelines for writing headings, subheadings, and word limit are very helpful hints provided for the authors in the journal template. It is essential to writing a research article successfully to build the right structure for it (Perneger & Hudelson, 2004).

Step 6: prepare the final draft

At this stage authors need to review the article to do the final refining in order to meet the journal expectations. A proof reading including checking the grammar and spelling of the words, as well as accuracy of citations and references is inevitable. This guarantees that the authors will not face unexpected delays in the publishing process. The authors also need to inform the editor, through a letter, whether they have included a soft copy of the article (which is attached to the electronic letter) or a hard copy sent by mail. Now that the article is finely fit to the journal frame it enters into the "editorial and peer review process" (International Journal of Orthopedic and Trauma Nursing, 2010 cited in Driscoll & Aquilina, 2011).

After suggesting the aforementioned six steps in writing for publication, Driscoll and Aquilina (2011) introduced the process which is "beyond submission". Sharing their experience, they mentioned that after two weeks of submission the author receives a letter which informs them that the article is received by the journal. It still does not mean the article is completely accepted. Then the journal sends the article to external reviewers and this also takes about six to eight weeks. Next, the author is informed that whether the article is accepted without any revisions needed, or accepted

under the condition of amending the text. The worst reply, even at this stage, could be rejection of manuscript.

The discussion here is that, like other scholars in the field, Driscoll & Aquilina limited the writing process of a RA by breaking it up to some steps for the authors to follow in order to succeed. Although by breaking up the writing process into smaller portions studying would be easier and provides clearer understanding, having a holistic eye on the whole research process and seeing the actions and interactions between and among various components in the process of producing the RA text would provide us a richer definition of "RA writing process".

Suggesting some advice for beginner authors in writing research articles, Perneger and Hudelson (2004) have an interesting opinion about the number of research questions in an article. They encourage novice authors to publish "several" articles if their research has the potential to answer "several distinct research questions". Another help Perneger and Hudelson, as editorial board of their journal, provided for novice writers was a table displaying the common mistakes observed in submitted articles for publication. Such realistic and practical papers would highly suit the needs scholars have in knowing about research article writing.

Writing-for-Publication

Researchers confirm and confess that RA writing has several stages as well as different processes (Burrough-Boenisch, 2003; Creswell, 2007; Driscoll & Aquilina, 2011). There are numerous studies on various processes within the whole research process, or so called writing process.

Research articles are written for a target audience provided by a journal or a conference. A "typical" research article follows a sequence of some certain sections.

They start from introduction and then come methods, results and discussion. They are sometimes abbreviated as "IMRAD" (Perneger & Hudelson, 2004).

Authorship in Collaborative Writing

"We can claim ownership or authorship of our thought or words after we have appropriately internalized the other's discourse through evaluative interactions with an understanding that we can never be the "only" owners or authors of our words. For example, critique of and personal perspectives toward previous studies in a specific field can demonstrate our authorship or ownership of our own thinking. However, even as we do so our ideas built from the words of others" (Lin, 2003).

Galam (2011) reveals each author's role in co-authored articles by separating junior and senior authors, who does the technical works, who does the writing. A higher percentage of multi-authored papers are in disciplines like clinical, science, engineering, and as such. On the contrary, in social sciences and especially in education and language studies most studies are single authored or co-authored by two researchers. Hence, most studies used as literature background in this study are from other fields rather than education or language teaching.

According to Bakhtin (2010), "our thought and ideas are originally from others' discourse and voice, and we cannot claim ownership or authorship of our words until we have appropriately assimilated, internalized, or evaluatively interacted with others' discourse. Thus, in the contexts of writing activities, we will never be the only authors of our writing; we have partners to co-construct meaning and mediate authorship".

Multi- & co-authorship. Reviewing the literature of authorship in the last three decades indicates a dramatic increase in co-authored and multi-authored RAs.

Researchers have examined various aspects of authorship in detail. Among the debates are subjects such as ethics of authorship, changing trends in number of authors, and the authors' name order.

Meanwhile, research shows a new trend in authorship, a global increase in the number of multi-authored research articles in different discipline (Brown et al., 2011; Yarcheski et al., 2012). This is mostly because "Cross fertilization of ideas" and saving of time and labor increase the chance of getting published and benefiting from "funding opportunities" (Cho, 2009; Zutshi et al., 2012).

Driscoll and Aquilina (2011), in a co-authored research article, assert that "writing collaboratively and making sense of two individual perspectives has proved challenging but rewarding". Meanwhile, Andrew J. S. Coats (2009), the editor of the "international journal of cardiology", reports the increase of problems in authoring research articles. He strongly points out that they keep an always open eye on the misconducts in authoring RAs. In addition, Coats (2009) provides seven "principles of ethical publishing":

1. That the corresponding author has the approval of all other listed authors for the submission and publication of all versions of the manuscript.

2. That all people who have a right to be recognized as authors have been included on the list of authors and everyone listed as an author has made an independent material contribution to the manuscript.

3. That the work submitted in the manuscript is original and has not been published elsewhere and is not presently under consideration of publication by any other journal. The oral or poster presentation of parts of the work and its publishing as a single page abstract does not count as prior publication for this purpose.

4. That the material in the manuscript has been acquired according to modern ethical standards and does not contain material copied from anyone else without their written permission.

5. That all material which derives from prior work, including from the same authors, is properly attributed to the prior publication by proper citation.

6. That the manuscript will be maintained on the servers of the Journal and held to be a valid publication by the Journal only as long as all statements in these principles remain true.

7. That if any of the statements above ceases to be true the authors have a duty to notify the journal as soon as possible so that the manuscript can be withdrawn.

Flanagin et al. (2002) provided some criteria for authoring multi-authored RAs in "International Committee of Medical Journal Editors Criteria for Authorship":

Each author should have participated sufficiently in the work to take public responsibility for appropriate portions of the content. One or more authors should take responsibility for the integrity of the work as a whole, from inception to published article. Authorship credit should be based only on (1) substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; and (2) drafting the article or revising it critically for important intellectual content; and (3) final approval of the version to be published. Conditions 1, 2, and 3 must all be met.

Looking at multi-authored texts, scholars such as Galam (2011) have tried to compute and devise mathematical formulas to measure the relative contribution of each participant in the writing process. They try to allocate authorship based on the contributions each author makes to the article. While this kind of research is important

in explaining the relative contributions of co-authors, it does not address other aspects which may be of equal importance. Aspects like, how relations are managed in the process of collaboration, how certain people are foregrounded or backgrounded in the process, how power relations, seniority, and authority in the field, shape the ability to contribute or not to contribute. Hence, the present study looks at the authorship issues involved in the writing and publishing process of a multidisciplinary multi-authored research article.

Ethics in authorship. Final section of almost all published articles, before references, provides a small note for readers: "Author order and writing strategy were agreed at the start to avoid any undue tensions. The alphabetical author order indicates the equal contributions made by each author", Burgoine et al. (2011). There are lots of studies providing guidelines for the authors in specific disciplines which are more or less the same for a variety of fields in research, e.g. Coats (2009).

It is interesting that most studies on multi-authored text are in fields other than social sciences such as medicine; an example is a study by Driscoll & Aquilina (2011). But in social sciences when researchers focused on research articles they worked either on the text or the text composed by a single author which seems more traceable than multi-authored texts.

Unfair authorship is another sub issue under authorship (for example: Geelhoed et al., 2007; Sandler & Russell, 2005). Depending on the seniority or authority in research teams, people force the name order or adding their name as authors.

New Trends in Collaborative Writing

The number of published multi-authored RAs in English has increased globally in all disciplines(Brown et al., 2011; Yarcheski et al., 2012). "Cross fertilization of ideas" and saving time and labor increases the chance of getting published and benefiting from "funding opportunities" (Cho, 2009; Zutshi et al., 2012). These new platforms are provided by advanced communication technologies such as wikis, emails, blogs, and live-chat (Kuteeva, 2011; Leuf & Cunningham, 2001; Li & Flowerdew, 2007; Liu, 2011; Lund, 2008; Zutshi et al., 2012). Although facilitating, they have added more complexity to the process of writing multi-authored RAs. Increase in the ratio of multi-authored RAs highlights the need for re-conceptualization of written genres (Badley, 2009). Complexities of multi-authored RA writing and publishing process require more dynamic and holistic approaches.

Writing in the virtual-collaborative space of a wiki enhances the audience-awareness of novice writers up to 60% (Kuteeva, 2011). Besides, wikis have the potential to produce and improve collaborative language learning and enhance "collective knowledge" (Lund, 2008).

Theoretical Considerations

Two theoretical frameworks which guided the data analysis of the present study were "Complexity Theory" (Larsen-Freeman & Cameron, 2008) and "Model of Parameters Involved in Writing" (Grabe & Kaplan, 1996, 2014). Complexity theory was the main theoretical foundation for the present study. Diane Larsen-Freeman was one of the key figures who improved and applied complexity theory in linguistics (1997). Model of parameters involved in writing served the analysis of the produced drafts of the research article. Both complexity theory and model of parameters involved in writing are introduced in the following sections.

But, prior to discuss complexity theory, here I shall introduce another framework called agency theory in order to better explain the features of complexity theory. Since the present study did not apply agency theory, it was only briefly introduced as a historically relevant framework to complexity theory.

Agency theory. To Eisenhardt (1989), *agency theory* is the updated version of *organizational theory*. She also argues that "agency theory provides a unique, realistic, and empirically testable perspective on problems of cooperative effort". Clegg (2005) defines agency as a suitable theory which can provide explanation for choice-making act of academicians, including students, their engagement in discussions of education, and how they "act to resist, restructure and preserve aspects of the complex system called higher education". Moreover, in order to understand our daily acts we should consider "ourselves as agents with the potential for collective agency".

The aspect of human agency is highlighted in the present study in which researcher-authors were the human agents or human elements of the complex system. "We exert our own agency and intentionality, creating, producing and reproducing systems through our daily interactions, and in turn those systems constrain and influence the way in which we behave (Morrison*, 2005, p.313). The complex system of writing and publishing a multidisciplinary multi-authored research article "can be thought of as a dynamical, open, complex adaptive system [which] has to be addressed holistically rather than as the sum of its parts" (p.315). In such system human agents (researcher-authors, journal editors, experts outside the research team) play crucial roles in directing the behavior of the entire system and all interactions among components of the complex system.

Complexity theory. In defining complexity theory the term "complex" is not simply and merely equal to complicated. A complex system comprises of a number of agents and components in which dynamism and interactions among them build the whole system behavior. Since the entire system is not bigger than "the sum of its parts" it is appropriate to view a system holistically (Larsen-Freeman & Cameron, 2009, p.22; Morrison, 2005). In other words, actions and interactions of components build the behavior of the whole system. Thus, examining each component separately only gives us insight about that component. It cannot help with understanding of the whole system (Larsen-Freeman, 1997). Because "getting a scholarly article published is a complex process" (Cheung, 2010). The present study took advantage of this approach and holistically looked at the complex system of writing and publishing RA by multiple ESL authors.

In the opening pages of their book, Larsen-Freeman and Cameron (2008) provide an introduction to complexity theory by giving a history of originating fields. They claim that biologist Conrad Waddington was the main figure who influenced the development of the concept of complexity theory in 1940 (p.2). The theory came to existence mostly from biology, mathematics and physics. Later, researchers in other disciplines including linguistics applied and adapted the theory. In most cases the theory became localized by researchers in their discipline. Table2.2 provides a summary of historical background to complexity theory (based on Larsen-Freeman & Cameron, 2008, pp. 2-21).

Table 2.2

Origins of Complexity Theory

Year	Researcher(s)	Theory/Model	Field/Focus
1940	Waddington	Construction process of embryogenesis	Biology
1958	Neumann	Cybernetics	Computer
1972	Thom	Catastrophe theory	Mathematics
1972	Lorenz	Butterfly Effect	Meteorology
1984	Santa Fe Institute	Complex Adaptive systems	Multidisciplinary
1995	Gelder &Port	Chaos Theory	Physical systems
1997	Larsen-Freeman	Complexity Theory	Linguistics

As Larsen-Freeman and Cameron (2008) assert, during the past twenty years applying complexity theory in a variety of disciplines (in addition to the originating fields) has continued to be efficient. Disciplines such as business management, economics, psychology, and linguistics are among areas where scholars benefitted from this theory and its elements (pp.4-5).

In contrast, there is another group of scholars who strongly criticized the scope and the use of complexity theory. Predictability of complex systems (Reitsma, 2003; Schneider & Somers, 2006; Yockey, 2002) rather than being unpredictable, emerging structures and patterns within complex systems (Karimi-Aghdam, 2016), and untrustworthiness of complexity theory for studying language-oriented systems (Gregg, 2010) are among the issues raised by the critiques of complexity theory.

Elements of complexity theory. The theory modified by Larsen-Freeman (1997) deals with the systems which are dynamic, complex, nonlinear, chaotic, unpredictable, and sensitive to initial conditions. They are also open, self-organizing,

feedback sensitive, and adaptive. Besides, having strange attractors and fractal shape can be added to the list of features of complex nonlinear systems. Environment is also part of the system, in which the components of the system act and interact. "A complex system owes its existence to relationships with its environment, defined as anything outside of the system, although this division may not be sharp" (Manson, 2001). The features of complex systems, defined by Larsen-Freeman (1997), are briefly introduced here:

Dynamic systems change over the time. They involve with active processes such as the use of language in written or spoken discourse. Language is an organism, dynamically growing and changing over the time.

Complex systems have large quantities of components or agents. All components are interacting with each other. Every action by agents receives the reaction of other agents or components. Complex systems, like languages, are composed of many interdependent subsystems.

Nonlinear systems are the ones in which components do not follow the law of cause and effect. Each act may be replied by different reactions by different components in the system. No effects can be guessed in advance.

Chaotic systems do not follow pre-set rules or actions. There is complete randomness in these systems. Interestingly, in the existing literature scholars have also separated Chaos theory from Complexity theory. The following quote is an example of providing the differences of the two theories:

"Chaos Theory deals with simple, deterministic, nonlinear, dynamic, closed systems. They are extremely sensitive to initial conditions resulting in an unpredictable chaotic response to any minute initial difference or perturbation. Complexity Theory

focuses on complex, non-linear, open systems. Complex systems respond to perturbation by self-organizing into emergent forms that cannot be predicted from an understanding of its parts" (Reitsma, 2003).

Unpredictable systems include never-repeating patterns. Stages come after each other based on the constant change to the whole system. Using the example of the shape of a tree from far and the size and color of its fruits it can be explained that the attributes of a complex system are "neither predictable nor reducible to properties of lower-level components and processes" (Karimi-Aghdam, 2016).

*Sensitive to Initial Conditions***,** complex systems display unpredictable behaviors depending on the initial stimulus. Even a small change in one component or a simple action by an agent changes the whole behavior of the system. A good example is represented by "butterfly effect" (Lorenz, 1972). A flap of a butterfly's wing here can cause a tornado thousands of miles away in another continent. The initial conditions or initial states (Karimi-Aghdam, 2016) of a system regulate and dominate the forthcoming states or conditions of the complex system. But interestingly some theorists such as (Yockey, 1977); Yockey (2002) believe that the amount of complexity can be computed in complex systems being studied in disciplines such as genetics and information sciences.

Open systems embrace new matter and energy coming from outside. But this does not affect stability of the system. System's adaptability helps changes to take place and fit into the whole system.

Adaptive systems take advantage of whatever happens and actively turn to adapt to the new changes.

Self-Organizing systems generate new and "emergent modes of behavior" after each change (Larsen-Freeman & Cameron, 2008, p.229).

Feedback Sensitive systems react to the feedbacks received from whether within or outside of the system. Reactions rise from the dynamic nature of these systems.

Strange Attractors are chaotic and non-periodic paths of a dynamic system. They are called strange due to the unpredictable reactions of components which result in new behavior of the whole system and change in direction. Although the general pattern of a research article is globally recognized, it seems impossible to guess what the components will look like.

Fractal shape of a tree is very similar to the shape of a complex system. Although the whole shape is predicted as "a tree", no single branch or leaf is similar to the other. For the process of writing a RA, the total process and the final outcome of the process (RA text) may possibly be predicted, but the sub-processes and single components of the research process can never be predicted. Changes at one level of the system, is reflected at other levels and consequently the whole system changes its pattern too.

Change, adaptation, and context. Complexity theory deals with interconnected dynamic systems, in which components and agents are exposed to continual change. This change results in adaptation of the whole system. In a system, context is not an entity outside or separate from the whole. Context is an inborn part of the system and is interrelated with each sub-system alone as well as with the entire system. The information about the system automatically includes information about the context as well (Larsen-Freeman & Cameron, 2008, p. 16).

Positioning human beings in a complex system by answering the question of "*how individuals can be located in complex systems*?" Geyer (2004) elaborates that human beings are united elements of their complex "physical and biological surroundings". And Valle Jr (2000) tried to introduce the elements and agents involved in the complex systems by stating:

A complex system is one in which numerous independent elements continuously interact and spontaneously organize and reorganize themselves into more and more elaborate structures over time. Complexity is characterized by: a) a large number of similar but independent elements or agents; b) persistent movement and responses by these elements to other agents; c) adaptiveness so that the system adjusts to new situations to ensure survival; d) self-organization, in which order in the system forms spontaneously; e) local rules that apply to each agent; and f) progression in complexity so that over time the system becomes larger and more sophisticated.

Flower and Hayes (1981) assert that, no clear boundaries could be defined between the stages of writing a text. It is a weak assumption to set distinct steps for writing RAs and considering a linear order for stages within the writing process. But, they can be viewed as components of a complex system which mostly overlap each other and develop the process recursively. Changes made to any single component influence the entire system.

The awareness-raising of the process of composing RAs can have benefits for academics and graduate students, especially those for whom English is a Second or Foreign language. Several researchers (e.g. Burgoine et al., 2011) have argued that the process of writing and publishing RA should be demystified. Although these studies are helpful in the sense of awareness making, they do not help us capture full view of

RA writing and publishing process, a "naturally complex" system of interconnected components (Zamel, 1982).

Model of parameters involved in writing. The second framework which helped the researcher of the present study analyze the collected data was the model of parameters involved in writing (Grabe & Kaplan, 1996, 2014). In chapter eight of the book "Theory & Practice of Writing", which was titled as "Towards a theory of writing", Grabe and Kaplan (1996, p. 202) asserted that they tried to answer the fundamental question of "what is writing"? Later, they explained that the question would be answered through an ethnographic approach towards writing. Eight parameters involved in writing were discussed in the book to answer a holistic question raised by Cooper (1979):

"Who writes what to whom, for what purpose, why, when, where, and how?"

In the following paragraphs the eight parameters of *who; writes; what; to whom; for what purpose; why; when and where;* and *how* are briefly discussed and at the end Grabe and Kaplan's model of parameters involved in writing is presented.

To discuss "*who",* Grabe and Kaplan (1997, pp. 203-204) first tried to classify the types of writers. They raised the issues related to the writer's experience, range of writing expertise, and purpose of writing. They believed that a novice writer's writing is different from "a mature experienced writer". Also it is important that some writers write in a variety of ranges while others may only write in a few limited fields. An interesting issue, mentioned by Grabe and Kaplan, was the purpose of the writer for writing. One writer may be a student who seeks academic prestige through writing, whereas the other is a professional journalist for whom writing is a source of income. Therefore the way they look at writing depends on the reason they write for.

The "*writes"* reflects the action or process of writing through which the text is constructed and it explains how the parts of written text are linguistically related. It means how words are related at first place to form a sentence, and later how these sentences can form a paragraph, etc.

"W*hat"* refers to types of writing, the writer's background knowledge, and the content. Types of writing are related to different genres and registers. Genres include the properties, purposes, and the structure while register highlights the topics around which the text is written. The writer's background knowledge, somehow, mirrors the writer's cultural context.

Audience is the "*to whom"* parameter involved in writing. The produced text and the meaning which is generated within the text essentially need an audience. The text is intended for the reader to read it. Therefore the reader's characteristics such as their quantity, shared knowledge with the writer, and closeness to the writer are the important factors that form the audience of a written text.

"For what purpose" a writer writes, reflects his/her way of communication with the readers. Writer desires his/her text to be read by an audience other than himself/herself. So the purpose must be conveyed in a way that the reader understands the message. Both writer's and reader's ability to communicate through the text serves the purpose for which the text is produced.

"Why" parameter involved in writing refers to the "underlying intentions or motives" (Grabe & Kaplan, 1997. P. 211) of the writer. *Purpose* for writing is not dependent on genre whereas *Why* reflects the reasons for which a writer writes in a specific genre, only intelligible for a selected audience. For instance legal or technical

documents are written for a special group of readers. The level of text difficulty categorizes the readers' level of comprehension.

"When and where" a text is written is not as important as when and where speaking takes place. The time and place of speaking situation is critically important regarding the speaker's purpose and his/her language use. This does not mean that when and where a text is written must be neglected. This means depending on the written text the time and place of text production becomes important. For instance, it is crucially important for a police detective to approximately know the date of a written message on a slip, in a crime scene. Or the readers of poetry find it very relevant when they get to know that the poet produced the poem through the night when he was hallucinated.

"How", in the ethnography of writing presented by Grabe and Kaplan (1977), is the final parameter involved in writing which is discussed (p.213). *How* a text is produced, mostly reflects the writing process. Some aspects of writing process highlight the physical act of writing; whether the text is generated using a pen, or a computer keyboard. Various writing processes are recognized in various cultures. All these influence *how* a text is produced.

Even though Grabe and Kaplan called this ethnography of writing a "tentative" model of parameters involved in writing (1997, p.214), it is undeniable that three of the parameters are the most fundamental aspects in writing which cannot be ignored or erased from any writing situation or written discourse. I summarize the three parameters in one question here which consist writer, text, reader:

"Who writes what to whom?"

"Who writes" represents the writer and all other parameters related to him/her as producer of the text, such as writing process, writing situation, culture, and so on.

"What" parameter can be considered as the center for act of writing; the text is the communication channel for the writer and reader. Different genres, modes of written text, purpose of the text, and the length of the text are some aspects of the writing product.

"To whom" is the reason that a writer produces a text; the reader who plays the role of audience in the written discourse. The readers' characteristics, including their background knowledge, is very significant for the writer who attempts to convey a shared meaning. Figure 2.1 displays the parameters involved in writing introduced by Grabe and Kaplan (1997, p.215).

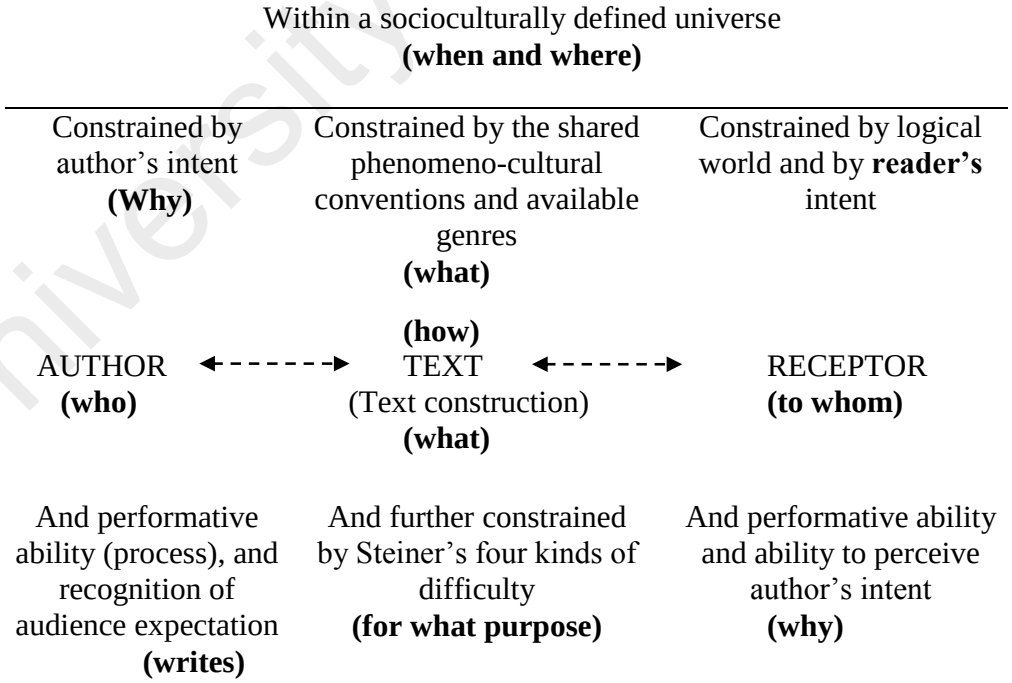

Figure 2.1 Grabe and Kaplan's parameters involved in writing (1997, p.215)

Methodological Differences in Related Studies

A number of researchers conducted case studies. Pifarré and Fisher (2011) case study employed twenty five (9-10 years old) pupils. Their study, to a great extent, comprehensively an inclusively mentions all existing approaches towards writing process and processes within writing/ writing processes. But, it still lacks sufficient attention to the differences between writing processes of, for instance, an email-writing task (Yasuda, 2011) and an authentic task of writing a RA. Flowerdew (1999a) took advantage of a "large-scale survey" to study the publication of Chinese academics which is certainly a quantitative method to collect data. Following this study in another article he made use of "in-depth interviews" which were conducted during three years. Participants were encouraged to provide longer answers to the interview questions. Then the gathered data was analyzed by ATLAS.ti software, an instrument which assists researchers in sorting and resorting data from interviews (Flowerdew, 1999b).

For the 2007 study, Li and Flowerdew distributed questionnaires during some semesters and also interviewed some of the participating students based on their experience on publishing research articles. In addition to these participants, several science professors were also involved in the interview process. A total of 300 participants responded the questionnaires among which some were interviewed as well. As conducting this study took about three years, during this time researchers case studied some of the participants in order to see how a Chinese L1 English speaker's paper is shaped. Specifically, for this study (Li & Flowerdew, 2007) they selected the data from a total of sixteen students and professors writing for publication. First, they were interviewed in Mandarin (Chinese participants' L1) while the interview sessions were all recorded. Then recordings were transcribed verbatim.

Similar Studies in the Field

Badley (2009), (Li, 2006); Li (2007) and Susser (1994) are some key research works having comparable considerations to the present study. But they have only remarked the existing problem and discussed it theoretically. They located the problem and introduced it to researchers as a potential and almost untouched area of research. To them academic writing process has not been studied completely and holistically. For instance, to Badley, research process and writing process are considered separate processes whereas they are overlapping processes (of one event).

There is a small body of research on single-authored research article writing process by (Li, 2006); Li (2007). Her research was based on the process logs collected from one participant student during the process of writing the first draft of his article. Process logs were collected from him "after laboratory research and just before he began writing" (Li, 2007). Her approach to RA writing is "as if first comes the research, an active creation of new knowledge, and then comes the writing, a relatively passive assembling of what has already been achieved" (Badley, 2009); a view that the present study refuses to accept.

In her study, Li (2007) started collecting the process logs from the participating student "after laboratory research and just before he began writing". Despite the fact, Li's study seems quite similar to my study it describes how researchers so far have seen the process of writing. As if there is a beginning and end point to the RA writing. Here, again, I should highlight that conducting the authentic task of writing a research article is different from and more complicated than writing for fulfilling a course work task. Its authenticity is not against being joyful. Even writing RAs is a delightful (Badley, 2009) task if the writing is considered as a creative process in which the writer uses his/her creativity. And again by pinpointing this view of separation of research

process from writing process in RA writing process by Li (2007, p.60) who said " after Yuan had completed his laboratory research" the gap in theory of writing process of RAs or misunderstanding towards becomes clearer. Although writing process and research process seem two different processes, we should not forget that in the unique process of writing and publishing research article writing process is in a continuous interaction with other processes within research process. In other word, writing process of RA is within the research process and not after it is over.

Li (in her study in 2007) interfered with the process of composing the RA text by providing some sources for writing the "Results and Discussion" section. Where the student could choose any other way and the whole process and, following that, the text could be different if he did not receive any advice or help from the researcher. She also mentions that the "process of writing an article is a continuous process of argumentation". This is pointed out when her participant student is in the process of writing the RA and for them the research process is over now.

Burgoine et al. (2011) reported and reflected upon a workshop arranged for postgraduates on writing and publishing processes of research articles. Despite the article is not reporting the findings of a research process, it provides useful and practical points for students willing to publish RAs.

Generally, the method which is planned to be followed for data collection and data analysis in the present study is slightly similar to Li's (2006). Li collected the process logs in order to capture the flow of the whole work. Different drafts of the article written by participant student were also collected. Other sources of data were interviews, emails, submission processes, editorial processes, and several informants.

The difference between the present study and Li's (2006) study is that she had one participant, a PhD student, and all the researching process involves this student's first effort in production of his first draft of an article. But in my study a team of expert researchers, with a background of having several published papers and/or books, and a PhD student under the supervision of one of the authors comprised the participants of the present study.

CHAPTER 3 METHODOLOGY

Introduction

In this chapter you will read about research site and participants, research design and the main phases of the study, also about data collection and data analysis procedures. Since the research site was sensitive and the various ongoing research projects within the site were confidential, using pseudonyms was inevitable for protection of the intellectual property of the researcher-authors who agreed to be my participants. At the request of the participant researcher-authors, who were conducting research and wanted to publish their findings, (throughout this manuscript) pseudonyms were used for the research team members, the chemical elements used by them, and the target journals to which they submitted their articles.

In addition, a preliminary study which was conducted to help researcher familiarize with the research site and characteristics of the project is reported. The preliminary investigation helped researcher in choosing the design and method for doing this study, especially in data collection and data analysis procedures. The collected data were triangulated to prove the trustworthiness of findings (Creswell, 2008, p.266).

Research Site

The present study was conducted in a major research university in Malaysia, where research collaboration was commonplace and multi-authored texts were also well-established. The publication turnover and productivity was very high and science researchers joined as multiple authors to publish RAs collaboratively. Another reason for selecting this site was easy access and familiarity to the site; because I needed to follow up people who worked in a period of time. Besides, in this research university

English was dominantly used compared to other languages. As English was used widely, it made the site more accessible to the researcher of the present study.

The rationale for choosing this research team was first due to high frequency of publications which were mostly multi-authored. Also based on preliminary investigations, the research team was going to conduct a new research project which was new, in several aspects, to them too. The main author mentioned that they were going to have a twist in their research style, methodology, and selection of target journal for publication of their new research article. Besides, difficulties and significance of gaining permission to enter research sites and research team as an outsider who was also going to observe the whole research process through the eyes of a researcher did not seem very pleasant and welcomed. So, it was not easy for them to trust an outsider to gain entry to the site. Their "new idea" for research in the field, could be "stolen" before they could publish it in a journal (preliminary interview with Prof Tony, during the talk for granting researcher entry to the site).

To summarize, the following items were among the justifications for selection of a multidisciplinary research team who conducted a research project in science, produced drafts of RA, and finally published the research article in a journal:

a) High turnover rate in publication of science research articles, which typically takes 3-5 months from idea generation to publication, matched the scope of my

study as it captured all aspects of writing and publishing process and their influences on building the collective behavior of this process. In comparison, social science research typically takes a longer period to complete. This could affect the scope and duration of the research process.

b) My secondary school background in science helped me, to a great extent, comprehend the science research project and be able to convey and simplify the concepts for readers of this text who may not be from science background. I did not have fundamental problems in understanding the content of the research and as such the science content did not pose a problem in data collection and data analysis.

c) The preliminary study and the participants' willingness to cooperate with researcher was another positive point for conducting this research.

d) Scientific research was mainly conducted in laboratories and researcher did not face major problems to access the site. In contrast, social science research involves other human subjects and the researcher needs to seek ethical clearance from all involving parties to enter the site.

Participants. A multidisciplinary research team, comprised of several researcher-authors from chemistry, physics, and engineering background who had all published articles in a variety of journals in different fields, were the participants of the present study. Among them Dr Janie was the principal investigator and the team-coordinator who arranged almost everything during the research process. She was an award winning young scientist. Since the time she was a PhD student she had published almost thirty research articles in science. Her expertise and management as well as academic positions in various universities and colleges made her a strong figure in her field. Other researcher-authors in the team relied on her work. They were

nominated by Dr Janie according to their personal characteristics and academic background, especially their experience in research and publication.

To protect the intellectual property of the participant researcher-authors, researcher ensured the anonymity of researcher-authors as well as details of their project including the chemicals, their university and departments, journals, and other sensitive facts. Therefore, data from research project and from published research article was considered highly confidential. On the other hand, researcher had to set the scene for readers of this thesis to fully understand the structure of research project in science. In order to be loyal to both my participant researcher-authors and the readers of this manuscript, I provided necessary information about the project while using the pseudonyms for researcher-authors, journals, and the two main chemicals reflected in the topic of published RA.

The participants in the study were identified during preliminary investigations. The principal researcher-author of the team, Dr Janie said, because "science research is more of cross-disciplinary [now]" inevitably she used other researchers' expertise to complete the research team in order to conduct the research project. Table 3.1 provides a brief background of each researcher-author in the team; how the individual joined the team is also mentioned in the table.

Table 3.1

Researcher-authors' Profile

Pseudonym	Research Background	Joining Procedure	Publication
Dr. Janie	Chemistry & Physics; material characterization : Main author-writer	Principal Investigator	30 +
Dr. Nick	Chemical Physics: characterization, coauthor-writer, lab assistant,	Colleague and coauthor from previous projects	10+
Prof. Tony	Chemistry: electrochemistry, coauthor-writer, Advisor	Colleague and coauthor from previous projects, Dr Janie's doctoral supervisor	70+
Dr. Yang	Chemistry: Coauthor, lab assistant	Colleague and coauthor from previous projects	10+
Prof. Zarimah	Engineering: coauthor-writer, Voltammetry Advisor	Head of engineers, Prof Tony's Coauthor from previous works	20+
Dr. Harry	Engineering: coauthor, lab assistant, Voltammetry	Prof Zarimah's colleague, Prof Tony's Coauthor in previous works	7+
Dr. Lee	Engineering: coauthor, lab assistant, Voltammetry	Prof Zarimah's colleague, Prof Tony's Coauthor in previous works	10+
Mr. Ken	PhD candidate in Physics: lab assistant, synthesis	Doctoral student under Dr Janie's supervision	1+

Note. + represents "more than", therefore "30+" means the author had more than 30 publications

In Table 3.1, for instance, Dr Yang whose field of research was mostly in chemistry assisted the team in the laboratory works. He also had worked with Dr Janie before, in other projects. His publication of more than ten research articles, by that time, was another mark for him to be invited for the new project.

The multidisciplinary research project required expertise from chemistry, physics, and engineering. Each researcher-author had his/her own role to play during the research process. Researcher-authors contributed directly to the process of researching by their actions and interactions and also (in) directly to the writing of research article drafts. Hence, the research article was shaped and re-shaped several times from the presence and influences of each and every researcher-author in the research team.

***Dr. Janie*.** She was the principal researcher-author in the team of multidisciplinary researchers who conducted a research project in science. She was an award winning young scientist who (co)authored over thirty ISI-cited journal articles and had several proceedings or waiting-for-publication articles. Her past research was mainly sponsored by two Malaysian health and beauty companies. She was specialized in synthesizing graphene-based materials, a type of carbon which has densely packed atoms. The way she synthesized these materials was unique. This special method was her inspiration for most of her experiments. In the science research project that I studied, for the present thesis, Dr Janie used "hydrothermal method" for synthesis of different types of XY_2. This method is a common way of chemical synthesis in science.

Dr Janie was the main writer and editor of the research article text. She was the team coordinator, first author in the list of authors, corresponding author, and also the decision maker for the research project.

***Dr. Nick*.** He was an expert in physical chemistry, had both publication experience and several years of work in the science laboratories. His relation with Dr Janie, as her husband, and also co-working with her in several projects made him a physicist who also knows about chemistry experiments and publications. He worked with Dr Janie in the same department. They were assigned with several other projects too. In most projects Dr Janie benefited from his experience. Their frequent discussions, while working in the same office, helped both of them improve their knowledge and exchange their experiences. For the research project, that I studied its entire process, Dr Nick assisted in laboratory works, provided advice in the discussions, and dealt with providing materials for experiments.

***Prof. Tony*.** He used to be Dr Janie's doctoral supervisor during her PhD studies in chemistry. He was the most senior and experienced researcher in the team. He had published more than seventy journal articles and about the same number were waiting for publication. He had co-authored most of his articles with other scientists from various countries and disciplines. He was the senior advisor of this research team and helped in solving problems several times during the research process. Interviews with him revealed a lot of details in the process of writing and publishing multidisciplinary multi-authored research article. One important issue mentioned by him was the timing about publication, which is explained in chapter four of the present thesis. For the research project, Prof Tony provided advice on many different aspects including the processes of XY_2 synthesis, and Z_2 detection.

***Dr. Yang*.** He was Prof Tony's colleague in department of chemistry in another university in Malaysia. He had co-authored articles both with Dr Janie and Prof Tony in the past. He was following the research trend that Prof Tony had taken. Assisting Prof Tony in his laboratory works had made him an experienced experimental researcher. Also in the research project, he directed most of the experiments in the laboratory and reported the results to the main researcher-author, Dr Janie.

***Prof. Zarimah*.** She was the head of engineering group of the research team. She had published several co-authored articles with Prof Tony before. She was an expert in computation and analyzing the structure and dimensions of materials and particles. She provided help for scientists from other disciplines especially material sciences like chemistry and physics. Chemists and physicists benefitted from her expertise in their multidisciplinary projects. The equipment and expertise that Prof Zarimah and her colleagues possessed were among the reasons that scientists from other disciplines, including Dr Janie, relied on them and invited them to join their cross-disciplinary research projects.

***Dr. Harry and Dr. Lee*.** They were the two engineers who assisted Prof Zarimah in engineering laboratory. They had co-authored many publications with Prof Zarimah in the past. Although each of them had his own specialties in engineering, they preferred to be united in a team of researcher-engineers under Prof Zarimah's supervision to benefit from each other's experiences and variety of knowledge in the field.

***Mr. Ken*.** He was a final-year doctoral student in chemistry had Dr Janie as his supervisor. He had worked as a research assistant in several research projects since his Master's degree. In this project Dr Janie suggested him to assist in the laboratory

work but she had not promised to include his name as a co-author in the authors' list. Part of his PhD studies was related to hydrothermal method of material fabrication and this project had a lot of experience for him to grab from several experienced researchers in the team. Although his name did not appear in authors' list in the published research article, his influence on the researching process and drafts of the research article was not ignored or omitted from data sets. Like other researcher-authors he was also observed and interviewed whenever it was needed.

Preliminary study. To establish a relationship with the participant researcher-authors and familiarize with the research site and people involved in the project a preliminary investigation was conducted. A preliminary study conducted in a close-to-actual context can present the researcher a good view of the appointed case study (Yin, 2013). Hence, I decided to get the permission for entry to the research team's site to be as much closer to the actual context of the study as possible in order to foresee possible ways and potential obstacles of conducting this study.

First, I approached Dr. Janie, the principal investigator of the research team through a mutual friend. After initial interviews and meetings with her, she brought up the matter and discussed my entry to the site with the rest of the team. Fortunately, all researchers of the team had agreed on my entry to their research site, which was going to be the site for my study too.

Then, I was granted the permission to enter the site and conduct the initial visits for establishing rapport with all "potential authors" of the RA (the main author called them potential, because the research team was not fixed yet). Table 3.2 provides a summarized introduction of tentative participants of the present study (stated by main

author during preliminary study) whose position in the research team was stated in the preliminary study by the main author.

Table 3.2

Tentative Participants of the Study

Participants (all pseudonyms)	**Position (stated by main author)**
Dr Janie	Main / Corresponding author
Prof Tony	Dr Janie's former (doctoral) supervisor, now a colleague in chemistry
Dr Yang	Colleague from chemistry department
Dr Nick	Colleague from physics department
Prof Zarimah, Dr Harry, Dr Lee	Co-authors from engineering
Mr. Ken	Dr Janie's doctoral student

The team coordinator (principal author) agreed to provide the researcher with permission to enter the site and engage with the research process. She also negotiated with other members of the team upon researcher's presence in the site. By having permission to enter the site, researcher and his participants for this study established a good bond and a mutual trust. This rapport immensely helped the researcher accompany the team during the actual course of the research process in the authentic phases of the study.

The preliminary study also provided the researcher with useful information about the site, the whole research process, and the participants. First, and almost the most important, insight was the complexity of the whole process that aided the researcher in choosing a suitable theoretical framework which supported analyzing

and explaining this complex system. Second, there were issues within research process which influenced the text (RA) whether directly or indirectly. Depending on each research project those factors might vary (main author asserted); issues such as authorship, interaction among multiple authors, advantages and disadvantages of multi-authorship, and the target journal. Also after doing the preliminary study, I found that I might want to track different authors specifically to capture their contributions as the research progressed.

Consequently, the impact of preliminary study made researcher change and refine some aspects of research objectives and research questions, as well as methodological approach for conducting the actual study. It also provided more insights on construction of semi structured interview questions. Visiting the site made researcher revise the observation protocol in order to suit the actual study. In the present study interviews were the main sources of data along with observations. The drafts of RA which were shaped and re-shaped throughout the entire researching process were other sources of data.

Finally, at the end of the preliminary study the time that the researcher could be able to start the actual study was discussed. Since the research team comprised of very active researchers (based on their research background/authors' CVs provided for researcher reference) in publishing RAs in scientific journals, they frequently had new projects at hand to conduct. Interestingly, this team decided to have a twist in the way they conduct research and more importantly (for me as a researcher) they targeted a new journal which had a different scope compared to the ones they had experienced before this project (main author, Dr Janie, Dr Nick, and another researcher who was Dr Janie's doctoral supervisor, informed me during preliminary investigations). Besides, the turnover rate is high in science publications, compared to social sciences.

For this very reason researcher decided to follow the whole research process from the early stages until the RA was published in Journal B. Hence, the possibility of missing valuable data was very low.

Since my background (i.e. TESL) was different from participants' field (Science), I was introduced to some parts of research site including laboratories and discussion room. Yet, I needed to be more familiar with the entire site. Technical terminologies were acquired through participants' explanations in interview sessions. Participants also promised to provide the researcher with books or other essential sources, where needed, in order to assist him in recognizing the field's culture and literature.

Despite the fact that in the preliminary study no data was collected, it provided the base for manipulation of the actual study. The results from the preliminary study directed the data collection procedure, selection of suitable frameworks for the study, and dealing with eight participant-researchers from three different disciplines. The preliminary study also made me study some technical terms and procedures related to the researching process done by my participant-researchers.

Research Design

This study used a naturalistic approach to conduct a qualitative case study, so it was predictable what sort of data could be collected and how (Cohen et al., 2013, p.137). In displaying the link between qualitative research designs and the process of a phenomenon, (Bogdan & Biklen, 2007) state that "Qualitative researchers are concerned with process rather than simply with outcomes or products" (p. 6). The present study looked at the whole process of writing and publishing a multidisciplinary

multi-authored RA by ESL authors in science. The findings emerged from natural viewing of this process.

Case studies are useful tools for studying a process. They provide advances in the fields' base knowledge and serve the research on real-life situations by providing firm, abundant, and holistic explanations of a problem, program, and process in education. Hence, this study was conducted in the form of a case study design (Creswell, 2007; Merriam, 1998) to capture the influences of different components of research process on RA text. Therefore, observations, interviews, and changes made to different drafts of RA were the main sources of data collection.

Key phases of case study. One of the elements of naturalistic research set by Lincoln and Guba (1985) is that the researcher should determine "successive phases of the enquiry". The present study was comprised of two main phases coinciding with the two main phases of the research project conducted by participant researchers. They were writing and publishing processes of a multidisciplinary multi-authored RA in science (from conceptualization to publication of RA). In the first phase the researcher-authors conducted the research project and produced several drafts of RA (namely drafts zero to four). Production of the first finalized draft of RA (D4) was the end of phase one. Phase two started when the researcher-authors' submitted the finalized draft of research article to their first target journal, Journal A. Phase two ended when the RA was finally published in Journal B.

Boundedness of case. "A case study is an in-depth exploration of a bounded system such as an activity, event, process, or individuals. A bounded case "is separated out for research in terms of time, place, or some physical boundaries" (Creswell, 2008, p. 476). For the present study, the researcher tried to define the boundaries for the case regarding the criteria introduced by Creswell. The time in which the researcher

conducted data collection was about five months. The place was a major research university in a predominantly ESL context. And specifically the case was a research team comprising eight multidisciplinary researcher-authors who carried out the processes of writing and publishing one research article in science.

The case was a research project in science including the experiments which were executed in laboratories. Due to variety of experiments, several drafts were produced that lead to the final text, the published research article.

Data Collection and Data Analysis

In the present study, the writing and publishing process of a multidisciplinary multi-authored research article is considered as a complex system comprising a number of components such as researcher-authors, processes, and drafts of research article. Also the present research tried to view how different components of the complex system worked individually and interrelatedly with other components to shape the holistic behavior of the complex system. But in researching a complex system "knowing about the parts individually is insufficient", because it is "the interaction of the parts [which] give rise to new patterns of behavior" (Larsen-Freeman & Cameron, 2008, p. 231).

Because of the interconnectedness of the two main phases of this study, namely writing process and publishing process, data collection and data analysis are explained in detail under each research question. The qualitative research design of this study and characteristics of complexity theory, allowed researcher to collect naturalistic data. Laboratory works, interactions, composition of drafts, discussions, and other artifacts emerging from the whole researching process were taken into account as components of the complex system of writing and publishing a multidisciplinary multi-authored research article in science.

Although the main source of data in the present study were interviews with researchers in different states of the research project, other sources of data also helped researcher in triangulation of findings including observations of laboratory works, collecting the generated images, tables, texts and graphs, as well as observing the discussions of multiple authors.

Before providing information about the procedures of data collection and data analysis under each research question, the sources of data and data collection instruments are discussed in the following.

Instruments and sources. To obtain a rich and trustworthy data for the present case study, researcher tried to fully benefit from different instruments and sources of data by using different qualitative methods for data collection. Interviews, observations, and discussions were the most important instruments for data collection in this study, though they were used specifically to answer the research questions one and two regarding the processes of writing and publishing of the research article. In order to analyze different drafts of the research article, documents were the crucial data sources.

Interviews. The key data collection instruments were the interviews which helped researcher better understand the processes of writing and publishing the multidisciplinary multi-authored research article, specifically to answer research questions one and two. The interview data was the most important source of data in the present study. The initial interviews shed light on succeeding stages of research and also guided researcher in conducting subsequent interviews. I conducted interviews in different stages of the study with multiple authors, and transcribed the interviews. The main themes emerged from the transcriptions of interviews.

For the present study, interviews were conducted based on the semi-structured interviews. The questions were not preplanned, but researcher had general guidelines to lead interview sessions (see Appendixes A and B). The initial interviews with the researcher-authors were aimed to investigate how the idea or conception of RA was generated.

In addition, authors were interviewed in different stages of research in order to capture the gradual progress of the research process and the influences that other components had both on writing process and on the drafts of RA. While researcher got to learn the participants' view towards the subject, he avoided tampering the data by "imposing his own view on the research situation" (Creswell, 2008, p. 140-41).

According to the specific stage of the research team's project, I categorized my interviews to the times before a draft was getting shaped (i.e. Pre D), during a draft was getting shaped (i.e. Amid D), and after the draft was shaped by the researcher-authors (i.e. Post D). In addition, the first line of the following table provides the information regarding my initial familiarization with the principal investigator, Dr Janie.

Table 3.3 gives the list of interviews which were conducted in different stages of the present study, parallel to the researching activities of the participant researcher-authors who were involved in laboratory works, discussions, writing, and publishing processes.

Table 3.3

Interviews in different stages of this study

No	Stage	Interviewee(s) & No. of interviews	Remarks
1	Initial	Dr Janie (1)	Negotiation for conducting this study and permission to enter the site; duration of my participants' project;
2	Pre D_0	Dr Janie (2) Dr Nick (2) Prof. Tony (2)	I attended two of their meetings in which they were discussing aspects of their research project
3	Amid D_0	Dr Janie (1)	I asked questions regarding the arrangement of the research team. She also explain how the three elements (grants, real-life experience, expertise) catered the idea for their project
4	Post D_0	Dr Janie (1) Dr Nick (1) Prof Tony (1)	I got to know about the overall plan for the project, area of their research, approximate duration, members of the research team, journal selection for publication of their findings...

Table 3.3 continued

5	Pre D_1	Dr Nick (1) Mr. Ken (1) Dr Janie (1)	Dr Nick was the material provider: I found out how different percentage of each material can affect their findings. Mr. Ken was a PhD student for whom this project had huge experiences for him. Dr Janie and Dr Nick were husband and wife, their research collaboration was very successful (one from chemistry, the other from physics).
6	Amid D_1	Prof Tony (1) Dr Yang (1)	Prof Tony's concern about duration of their project and how it could affect their publication was interesting. He was previously Dr Janie's doctoral supervisor in another university. He provided a lot of consultations for the project. Dr Yang was Prof Tony's colleague in another university and he also joined the chemistry subgroup for this project. He adored Prof Tony's approach in conducting research especially laboratory works and quickness in publication.

Table 3.3 continued

7	Post D_1	Dr Nick (1) Dr Janie (1)	I asked about their use of some materials in the laboratory and how they impacted the results of laboratory work. Dr Nick clarified some misunderstandings I had during my observations. Dr Janie elaborated on how the XY2 particles were synthesized. Production of draft one (D_1) was the result of this stage.
8	Pre D_2	Dr Janie (1)	She explained how and why XY2 particles must be in bulk: to go for the next stage.
9	Amid D_2	Dr Janie (1) Dr Nick (1)	Dr Janie explained the characterization process and helped me fully understand what I observed during characterization. Dr Nick elaborated on the results from characterization of XY2 particles.
10	Post D_2	Dr Janie (1)	She explained that D_1 and D_2 provided the base for their research in detecting toxins in water and it was just the beginning.

Table 3.3 continued

11	Pre D_3	Prof Zarimah (1) Dr Janie (1)	She explained how the current research is cross-disciplinary and how the expertise of her team (of engineers) would help the project. Dr Janie explained how Prof Zarimah's work could contribute to the project, but the list of co-authors would be longer.
12	Amid D_3	Dr Harry (1) Dr Lee (1) Prof Zarimah (1)	Dr Harry and Dr Lee were the laboratory assistants of Prof Zarimah during the process of voltammetry. They provided the general information about this process. Prof Zarimah explained how a technical problem happened and changed the process of voltammetry. She also unfolded how the engineering subgroup provided data for the detection of toxin in water.
13	Post D_3	Dr Janie (1) Prof Zarimah (1)	Dr Janie described the value of Prof Zarimah's findings. I asked Prof Zarimah to interpret the voltammograms for me to understand their meanings and connection to the entire project and the produced drafts until then.

Table 3.3 continued

14	Pre D_4	Dr Janie (1)	She provided the insights for the conventions in assembling all produced drafts for writing of the research article.
15	Amid D_4	Dr Nick (1)	As a result of authority, Dr Nick's name was removed from the list of authors and he was really shocked.
16	Post D_4	Prof Tony (1) Dr Janie (2)	Prof Tony who had helped in the assembling of produced drafts was interviewed. He explained how he had to contact each co-writer for confirmation of their writings. He also said that they expected rejection as well every time they submit an article. Dr Janie elaborated on the general process of manuscript assessment by journals in her field. She also provided information about the target journal (Journal A) to which they decided to send their article. She described she had to follow the journal's scope and templated in drafting the final manuscript (D_4) before submission to the journal. Dr Janie angrily explained how the head of department imposed his power to remove Dr Nick's name from the list of co-authors. I asked why Mr. Ken's name was also not included, she explained that it was an agreement between them…

Table 3.3 continued

17	Pre D_5	Dr Janie (1)	Dr Janie showed me the email that Journal A rejected the manuscript. She was a bit upset about it, but not completely shocked because she had experiences like that before and already targeted other journals for submission. Although Journal A refused to publish their paper, it was generous in providing useful feedback.
18	Amid D_5	Prof Tony (1) Dr Janie (1)	During drafting of D_5 Prof Tony believed that due to the valid comments from Journal A, they had to synthesize more samples to enrich their data in order to increase the chance of acceptance by other journals. On the other hand, Dr Janie believed that the paper was in an acceptable condition and only modifications on text had to be implemented to suite the requirements of the second target journal (Journal B) for submission of manuscript.
19	Post D_5	Dr Janie (1)	I was informed by Dr Janie that Journal B has accepted the manuscript conditionally due to the insufficiency of samples synthesized by the research team and the inappropriate reporting of voltammetry process.

Table 3.3 continued

20	Pre D_6	Prof Zarimah (1) Dr Janie (1)	I asked Prof Zarimah about the drafting problem. She explained that she was not aware of the differences in the scopes and requirements between the two journals (Journal A and Journal B). She said she will re-draft the voltammetry process to suite the requirements of Journal B. Dr Janie described the reason their synthesis must be modified and how external experts could help with that issue. She advised me to interview Prof Tony and find out about his consultation with another colleague.
21	Amid D_6	Prof Tony (1) Dr Janie (1)	Prof Tony explained how he discussed their methodological issues with an overseas colleague and how it could be useful for synthesizing new samples. Dr Janie informed me about the new changes in draft five (D_5) which resulted in production of draft six (D_6). She also wanted to re-submit the amended manuscript to Journal B.

Table 3.3 continued

22	Post D_6	Dr Janie (1)	After Dr Janie re-submitted the manuscript to Journal B, I was informed by Dr Janie that the journal replied. She showed me the new feedback from journal and we discussed the next step that the research team was going to take.
23	Pre D_7	Prof Zarimah (1)	I interviewed her because a new voltammogram (multiple voltammetry of XY2 particles) was generated. She admitted that Journal B's requirements improved the way the engineering subgroup reported voltammetry process.
24	Amid D_7	Dr Janie (1)	I interviewed her to have insights regarding the required textual amendments. She explained how a single tilde can make the journal return the manuscript to them for amendments. She also informed me that draft seven (D_7) would most probably be the last re-submission.
25	Post D_7	Dr Janie (1)	She (happily) showed me that the manuscript had been fully accepted and Journal B would be publishing the paper soon.

Table 3.3 continued

26	Pre D_8	Prof Tony (1)	Prof Tony explained how these kinds of projects could be conducted much quicker in other countries such as China. He told me one of his real-life experiences when he lost one publication due to delays in researching process in one of his past projects.
27	Amid D_8	Dr Janie (1)	She showed me that their multi-authored research article was finally published in Journal B's website. We discussed the relation between the published paper and her future research and how it could build the base for the forthcoming projects.
28	Post D_8	Dr Janie (1) Dr Nick (1)	I interviewed Dr Janie to know about the difficulties and lessons learned from the research project especially how being an ESL writer would affect the processes of writing and publishing of the article. Dr Nick, whose name was unfairly removed from the list of authors had decided to leave the department. He believed such cases could easily make active researchers leave the university.

As you can see in Table 3.3, Dr Janie played the most important role in providing data during interviews. This was due to her position and responsibility in the research team. Dr Janie was the main and corresponding author of the article; she was the principal investigator of the research project; and she did all the official procedures for the supporting grants. Besides, she was the head of the chemistry-physics subgroup within the research team. Dr Janie also negotiated the co-authorship and collaboration with the head of the engineering subgroup, namely Prof. Zarimah.

In using interview data, another important issue which should be mentioned here is the use of excerpts in the analysis of findings. The interview data were used wherever necessary, regardless of the stage in which they were collected. In the present manuscript, for example you may see an excerpt from draft six (D_6) which is given under the analysis of draft three (D_3). It is because of the relevance of the interview data to the analysis of the associated draft.

Participant researcher-authors, involved in the research process, were interviewed in different stages to make sure that the researcher's observations were valid, reliable, and not biased. Among the research team members the focal participant, to be interviewed in different phases of the study, was Dr Janie, the principal investigator of the research project in science and the main author of the multi-authored research article. A semi-structured interview protocol was inspired by preliminary study (Appendix A). The questions were based on the literature and the preliminary study. But these questions were not fixed and only provided guidelines for the researcher of the present study. Depending on the actual situation, during interviews, I raised particular questions to probe. Post-observation interviews also included questions on scientific works and technical vocabularies, which were not fully recognized by researcher during observations. The answers to these questions

helped in clarification of the influence of components on each other and specifically on RA text.

Particularly relevant segments of recordings were transcribed verbatim for analysis. Since the present study was built on a naturalistic approach, the interview data were analyzed inductively/deductively depending on the answers provided by the researcher-authors and in different stages of the research process. I interviewed the participant researcher-authors, mostly after their experiments, to cross-check with my findings from observations of laboratory works or their discussions.

Observations. In tracing the processes of writing and publishing (i.e. researching processes) observations were the perfect instruments in providing good vision for the researcher. By observing the participant researcher-authors involved in different processes of their research project and noting down the reflection of those processes on drafts of the research article, researcher gained great data which was later triangulated with other sources.

Observations are highly dependent, in naturalistic research, on the context where observation is held. This relevance is "both in the immediate setting in which behavior is observed and in further contexts beyond" such as in interview sessions and in the produced drafts of the research article(Cohen et al., 2013, p.139). To the extent that multiple authors allowed, I attended the research site and collected data directly by "observing people and places" and utilized a researcher-designed protocol (Creswell, 2008, p. 643). All laboratory works and experiments, interactions and discussions between and among authors, and parts of the process of transferring information to the RA text were sources of data obtained through observations.

During the researching process, when the research team started to work, I joined them for collecting observational data, during which observation notes were taken. I looked at the laboratory activities done by each researcher and tried to jot down all the steps researchers took during the laboratory work. Sometimes, when they discussed during laboratory activities, I listened to them carefully and noted down the relevant points in order to better understand the flow of the researching process. There were times that I could not fully comprehend the processes and discussions between and among the researcher-authors. In such incidents, I had to put a sign ("int.?") beside my observation notes which meant "ask them later during interviews". Therefore, I later remembered to ask researcher-authors for more clarifications about the issues that I less understood.

Because of the delicacy of the research site and high confidentiality of research projects, researcher tried to be as non-interfering as possible during observations, specifically in laboratory settings and when the researcher-authors were discussing subjects about their work. Interactions between and among authors, their reactions towards the main author's requests, and the assigned work were observed and notes were taken. The observation field notes helped me record the processes and sub-processes within the researching process, guided me in planning my interviews, and kept me in track to see the reflection of all research activities on the produced drafts of the article.

Considering the fact that the researching activities and the meetings of the research team were not definite or set in advance, the unplanned observations were conducted whenever and wherever the researcher-authors had discussions, data collection, laboratory work, etc. To the extent that the researcher was allowed and informed to accompany the research team, while the researcher-authors were working,

the observations were conducted and field notes were taken. As an important source of data, observational notes were also categorized based on the impacts that various components had on each other and on the production of drafts of RA.

Documents and artifacts. Documents and artifacts which were collected as alternative sources of data in the present study comprised all drafts of the research article, emails exchanged between and among individuals, sticky notes, etc. Specifically, the focal documents in this study were the drafts of RA text in various stages of the research process. Dr Janie, the main researcher-author promised to provide researcher with all drafts of the research article as soon as they were produced. This way, researcher could grasp the gradual progression of RA text and linked the changes to the influences from each component.

Besides, researcher collected all other relevant documents, such as emails exchanged between and among authors, in order to capture the interactions and discussions related to research process (researcher's initial talks with two research groups from other disciplines revealed that they used a Facebook page for most of their interactions and discussions).

Document analysis of this study mainly focused on progression of different drafts of RA and changes to the text during the research process. One of the major analyses of the RA text was when the first final draft was submitted to the first target journal for evaluation. Since most research articles, submitted to journals, receive comments at the first point, if not rejected immediately, the changes to the first final draft were of great importance (RQ3).

Group discussions. Researcher also took advantage of other sources of data, explicitly the researcher-authors' group/pair discussions on different matters during

their entire research project. Obviously, researcher could not *always* have access or permission to the discussions.

In all stages of research and for answering all three research questions, researcher followed group discussions among the researcher-authors as much as possible. This type of observation helped clarify the hidden issues and influences that all components had on production of different drafts of RA text. Besides, it helped the researcher of the present study in triangulation of data by approving/disapproving the collected data from other sources such as individual interviews with each author.

I had an observation field note for group or pair discussions of the researcher-authors, when they chatted in the laboratory during the experiments or had meetings outside the laboratories discussing various issues. The field notes helped me record the important aspects of the researching process and always have a holistic overview of the past, current, and future stages of their project. The observation data was always cross checked with the findings from interviews and other sources as well.

Data collection and analysis for RQ1. RQ1: How is the process of writing multidisciplinary multi-authored research article carried out by ESL authors?

To answer this question researcher drew on all sub-processes of writing process, from idea generation to submission of RA to the journal. In this process, participant researcher-authors generated total of five drafts of RA (D0-D4). The fifth draft was submitted to the target journal for publication. Data analysis was based on the sub-processes in which each draft was generated. Analysis of drafts (five drafts in writing process and four drafts in publishing process) provided under research question 3 (RQ3). Where necessary, excerpts from interviews and observation data were given to provide "evidence to support a theme" (Creswell, 2008, p.266). Since in qualitative

research the themes are emergent, the themes for this study also emerged from the collected data. Figure 3.1 shows the steps through which the themes emerged from the qualitative data (see Appendix K for more details).

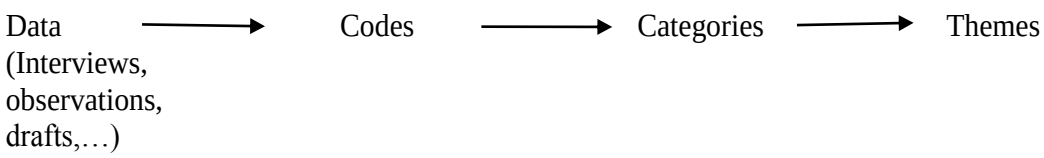

Figure 3.1. Data deduction and emerging themes

To answer this question, researcher had to observe the authors, their laboratory works, discussions, and interactions. Field notes were generated during observations. As RA drafts were shaped and re-shaped during the whole research process by multiple authors, it was almost impossible to observe authors writing-up the RA text in different time and place. To resolve this problem, researcher conducted post-observational interviews to see how research activities influenced the writing process and the drafts of research article. Missed sessions or unclear points, were investigated in post-observational interviews. Also, semi-structured/unstructured interviews were conducted "to review observational data before suggesting an explanation for the observed phenomena" (Cohen et al., 2013, p.305).

Since the principal author, Dr Janie, led the research team and she was responsible for all laboratory works, discussion sessions, and other research activities, the interviews with her were of utmost importance for this study. In the present study the progress-based interviews with the main author, Dr Janie, were the major sources of data. These specific interviews were structured in the way that they could help researcher in capturing the latest changes made to the RA text due to the act of writing and/or influences of other components on the RA text.

Besides, all documents including drafts of the RA, transcripts of interview protocols, field notes, and other artifacts helped researcher analyze the data by categorizing the emerging themes in order to answer research question one. This procedure continued until the research team submitted the first final draft of RA to their first target journal (Journal A). Also for other research questions of the present study study (RQ2 & RQ3) this process continued till researcher-authors received feedback from the journal, reflected on them and produced more drafts, and lastly until the final draft of the RA was published in the second target journal (Journal B). Appendix K of the present study includes more details on data reduction and data analysis.

Data collection and analysis for RQ2. RQ2: How is the process of publishing multidisciplinary multi-authored research article carried out by ESL authors?

The approximate duration of writing and publishing process of RA in science was one of the main concerns of researcher in the present study was. Hence, in initial interviews with Dr Janie, I raised the question on duration of their project. She explained that because of high turnover and frequency of science RAs, they usually expect to conduct the research project and publish their findings in form of RAs mostly in three to five months.

Dr Janie further elaborated, after they submit the final draft of RA to the journal, basically they receive one of the two feedbacks. First, the RA might get rejected and the journal would not publish the paper; in this case several follow-up reactions from the author(s) would be taken depending on many aspects. She did not explain more, because she believed every rejection had its own unique reason and the following steps all depend on other factors too. In the second type of feedback, the

journal editors and reviewers provided comments and required some revisions; so, the rest of the process would vary accordingly.

Hence, the main source of data in this phase is the journals' feedbacks and the consequent actions and re-actions of the research team towards the feedbacks and comments. By observing this process and interviewing the researcher-authors, the researcher of the present study collected the relevant data. Observations, interviews, group discussions, documents and other artifacts such as emails from/to the journals helped the researcher capture the whole publishing process.

The evolving incidences during the researching process helped the researcher investigate how the final draft of RA was accepted and when the process was ended. Furthermore, in research question three (RQ3) the draft which was finally accepted for publication, without further revisions needed, was analyzed in conjunction with other drafts collected throughout the whole study.

Data collection and analysis for RQ3. RQ3: How is the text shaped in the process of writing and publishing multidisciplinary multi-authored research article?

The main sources of data for answering this question were the produced drafts of RA from the whole process of writing and publishing multidisciplinary multi-authored RA. Researcher compared and contrasted the drafts of research article to capture the changes to the text.

To answer how changes took place in different drafts of RA, researcher benefitted from all other sources too. Non-textual components of the research project had either direct or indirect impact on the text. Thus, by analyzing the influence(s) of other components on different drafts of RA text, researcher explored how RA was shaped and re-shaped throughout the writing and publishing processes.

Table 3.4 displays a synopsis of research questions, data collection, and data analysis procedures.

Table 3.4

Research Questions, Data Collection and Data Analysis Procedures

Research Questions	**Data Sources**	**Data Analysis**
How is the process of writing multidisciplinary multi-authored research article carried out by ESL authors?	Observation Interview RA drafts Documents	Inductive/deductive analysis Document analysis
How is the process of publishing multidisciplinary multi-authored research article carried out by ESL authors?	Documents Interview Observation	Document analysis Inductive/deductive analysis
How is the text shaped in the process of writing and publishing multidisciplinary multi-authored research article?	Documents Interview Observation	Document analysis Thematic analysis

Data reduction and data analysis. In general, data analysis for the present study heavily depended on the naturalistically collected data. The themes emerged from the data and also guided the rest of the data analysis procedure. A detailed account of data reduction and data analysis, specifically the coding system for the present study, is provided in the following:

- From the main sources (interviews, observations, and documents) the data was transcribed, visited, and re-visited. Since it was a naturalistic qualitative case study, the initial ideas for potential themes emerged from the collected data.

Also, the preliminary study greatly inspired me for doing the actual data collection and data analysis.

- Interesting and relevant data, for answering the three research questions of this study, were coded in an organized manner.
- The coded data were systematized in such a way that possible themes could emerge from the codes.
- The emerged themes were re-examined by seeing their reflection on the coded excerpts, specifically, and later on the whole set of data. This resulted in generation of a theme-related view on the entire procedure of data analysis.
- The analysis did not stop here. It was an ongoing process, in order not to miss any specific aspect in each theme. This helped me in providing a better and clearer analysis of findings by looking at each theme thoroughly.
- For reflecting the analysis of themes on the text of this thesis, I tried to use the most interesting excerpts and examples which were also strongly related to the research questions and the reviewed literature. This led to reporting a trustworthy analysis of data.

By linking the three major sources of data for the present study (interviews, observations, and documents) the researcher could achieve a more reliable analysis. Appendix K holds more information on data reduction and data analysis for the present study.

Triangulation of Findings and Trustworthiness

The term *triangulation* came from naval sailors who used "multiple reference points to locate an object's exact position at sea" (Jick, 1979, p.602). But in research, triangulation refers to the use of different sources of data for analysis of a single

finding. This way researcher can credibly prove the authenticity and trustworthiness of his findings.

In qualitative approaches, the trustworthiness relies mainly on four criteria comprising credibility, transferability, dependability, and confirmability (Shenton, 2004). To prove credibility, researcher tried to present a clear picture of the findings in the present case study which highly relied on the real-life experiences of the multiple researcher-authors in the researching process.

Since there were eight participant researcher-authors in this study I benefitted from triangulation of data, for many incidents, by using observational field notes, interview protocols, drafts of the research article (as documents), and also by inquiring about the phenomenon from different individuals. Triangulation of data helped both in description of trustworthiness and thematization of findings. The data was coded to establish categories. Then the themes emerged from categories. Each data source was closely examined to find "evidence to support a theme" (Creswell, 2008, p.266).

Methods of data analysis, such as coding of data, were greatly inspired from the collected data in the present study. In order to let the naturalistic research flow lead the most suitable methodology for analyzing the data, Other factors which were learnt from the study included the influences of funding and various machineries on science research project, as a whole, and on the research article text, particularly. These aspects were parts of the real-life world of writing and publishing multidisciplinary multi-authored research articles (Golafshani, 2003).

An example of triangulation of findings for the present study which included authorship, expertise, and also multidisciplinary nature of the research project in science is given here. In production of draft three (D3) of the research article the

research team took advantage of the expertise of three engineer-researchers. To tease out the nature of the engineers' collaborations and contributions to the research project, and to the research article text, I triangulated the interview data from two individuals: Dr Janie, the principal investigator, and Prof Zarimah, the head of engineer-researchers. Dr. Janie explained why she had to use the engineers' expertise:

> … [Prof Zarimah's team] have the voltammetry [equipment] … and the knowledge to use the equipment for [extraction of] voltammograms. For the next step we need their work and [the] results from voltammetry. [That's why] there is [a] collaboration between us.
> (Interview with Dr Janie: Pre-D3)

From a later interview with Prof. Zarimah, the head of engineers of the research team, I tried to better understand how the engineers' work contributed to the research project. She explained:

> [Current] research is cross-disciplinary. Not all equipment are available [for every single discipline]… especially in government institutions we have certain fund, we need to help each other or … [sometimes] we have to pay to private institutions to conduct one part of our research. They sell their services. Or we can rent their laboratories …or equipment.
> (Interview with Prof Zarimah: Pre-D3 & Amid-D3)

Prof Zarimah also added that "for the present project [their] expertise was the reason for collaboration, not the possession of equipment". Therefore, from triangulation of interviews with two individuals (Creswell, 2008, p.266) from two

different disciplines, chemistry and engineering, the researcher could clarify the issues of multi-authorship and expertise.

This chapter provided the methodology for undertaking this study including research design, research site, participants, and the approach in collecting and analyzing data. Interviews played a key role in confirmation of the accuracy of the collected data from observation of participant researcher-authors and the produced drafts of the article.

The following chapter provides the analysis of the findings which are presented according to the three research questions of the present study. First, a map and an overview of the entire research is given. Then, the three research questions are answered.

CHAPTER 4 FINDINGS

Introduction

The present study attempts to examine the writing and publishing processes of a multidisciplinary multi-authored science research article through the analysis of a case study of a research project conducted by a team of researchers. The researchers involved in the project, came from a variety of disciplines including chemistry, physics, and engineering. In the present study writing and publishing the multi-authored research article (RA) is viewed as a complex system in which different components work interdependently to produce the text (see the discussion of complexity theory and complex systems in Chapter One and Chapter Three).

This chapter is organized on the basis of the three research questions of the study. Each question looks at a main component of the complex system. The main components are writing process (RQ_1), publishing process (RQ_2), and the written text (RQ_3). Research questions of the study are as follows:

RQ_1- How is the process of writing multidisciplinary multi-authored research article carried out by ESL authors?

RQ_2- How is the process of publishing multidisciplinary multi-authored research article carried out by ESL authors?

RQ_3- How is the text shaped in the process of writing and publishing multidisciplinary multi-authored research article?

Figure 4.1 presents an overall map of the present study by displaying the relation between the research questions and main components of the research project in science.

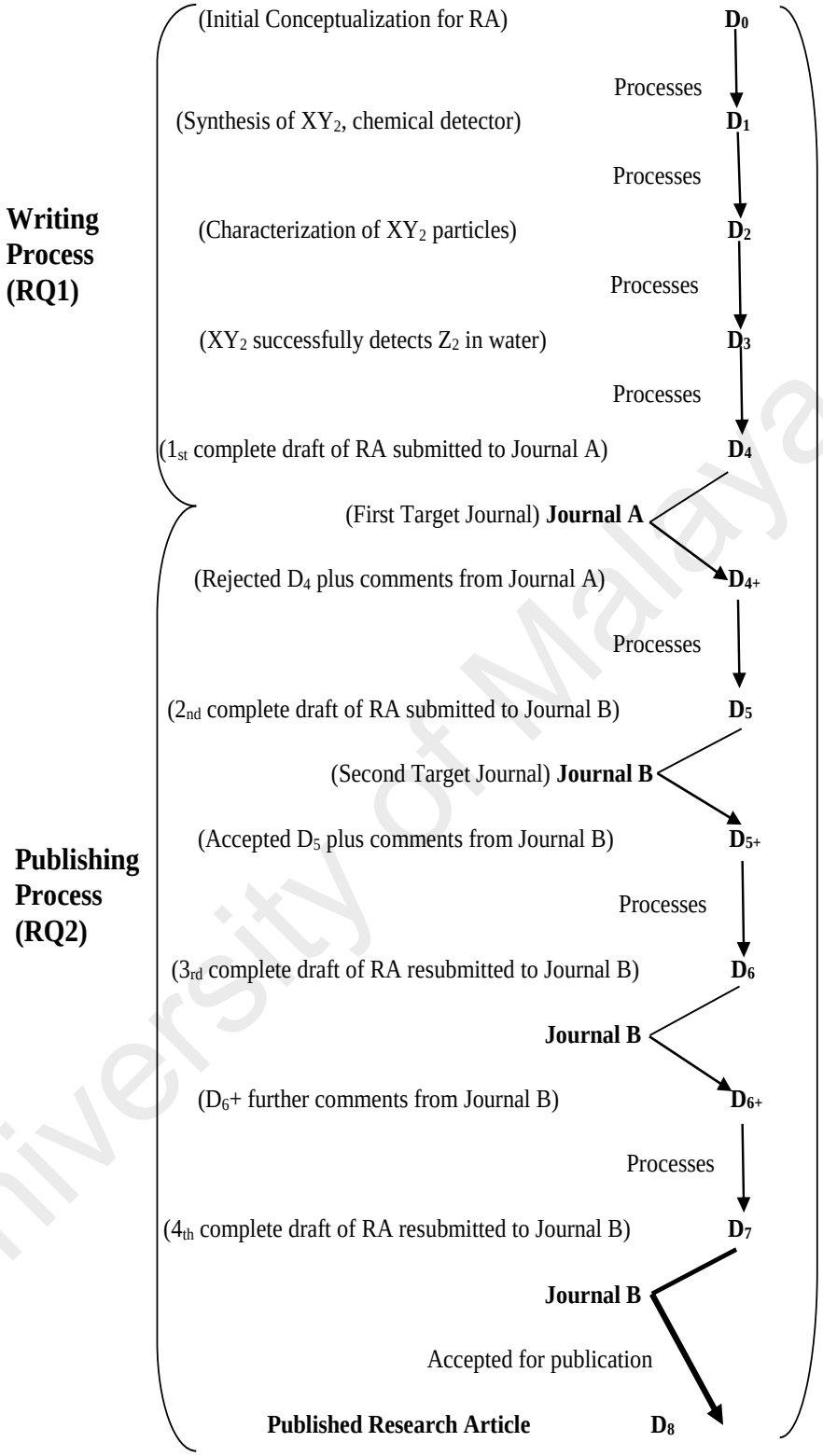

Figure 4.1. Writing and publishing processes and drafts of research article (D_0-D_8)

To set the context for the discussion of findings from research question one (RQ1), an overview of the whole research project, which was carried out by the team of researchers, is provided here.

Overview of the research project in science as a complex system. In the present study, the whole process of writing and publishing the multidisciplinary multi-authored research article is viewed as a complex system which comprised "interconnected" and "interdependent" components (Larsen-Freeman & Cameron, 2008). The three main components of the complex system were the writing process (RQ1), the publishing process (RQ2), and the written text (RQ3) (see Figure 4.1). While research questions one and two focused on the processes of production of drafts zero to draft eight (D0-D8) of the article, the research question three analyzed the produced drafts.

The principal author of the multi-authored research article, which was the focus of the present study, was Dr Janie, a qualified researcher in physical chemistry. She had published more than thirty articles which were mostly co-authored with multidisciplinary researchers. The present study looks at a research project that Dr Janie and her team of researchers conducted to see if the chemical element XY_2 (a pseudonym) could detect toxin Z_2 (a pseudonym) in water; throughout this thesis, pseudonyms are used at the request of the researchers to protect their intellectual property. This study investigated how the team of multi-disciplinary researchers organized the research process, produced several drafts of the article, and eventually published the article in a journal.

The research project had its beginning in Draft Zero (D_0) which provided the initial conceptualization for producing the research article. D_0 set the platform for the

research team to begin the research project. Through several processes of synthesis, the research team synthesized several types of XY_2 in laboratory. Draft one (D_1) reflected the results from the syntheses of different types of XY_2 particles. Draft two (D_2) reflected the scanning images from characterization of XY_2 particles by a characterizer equipment. Characterization provided necessary information for the research team to select certain XY_2 particles which showed the potential for detection of toxin Z_2 in water. Draft three (D_3) reflected the Voltammograms produced through processes and experiments from which the research team reached a type of XY_2 which successfully detected toxin Z_2 in aqueous condition. The final state in the writing process was to gather all the findings and drafts from previous states together. Draft four (D_4) was the first complete draft of the research article (RA) which was submitted to the team's target journal (Journal A).

The writing process started when the idea of the research article was generated in the mind of the main author, Dr Janie. It is worth noting that in the process of writing and publishing a multidisciplinary multi-authored science research article we cannot completely and simply separate the two processes of writing and publishing. They are interrelated components of a complex system and are connected interdependently through several links, explained in the analysis of findings. In the present study, where the writing and publishing process of a multidisciplinary multi-authored research article is viewed as a complex system, in order to better understand each component the researcher needed to focus on one component at a time. To study a complex system, "one can, indeed one needs to, foreground a focal point, while allowing the background [other components] to continue on its dynamic trajectory" (Larsen-Freeman & Cameron, 2008, p.234). When a focal component is under study

it is still interacting with other components which are also working within the system. In the present study the writing process is the first focal component to be analyzed.

The publishing process started with the submission of D_4 to Journal A for review (see Figure 4.1). Although Journal A did not accept D_4 for publication, it provided useful feedback for the research team to improve their article. Thus, based on the feedback from Journal A, the research team produced draft five (D_5) and submitted it to their second target journal (Journal B), which accepted the article for publication conditionally, subject to some revisions. Then the research team followed the required revisions from Journal B, produced draft six (D_6), and re-submitted the draft to Journal B. This time, the newly submitted D_6 required further minor revisions. So, the research team produced a new draft (D_7) according to Journal B's directions. Draft seven (D_7) was the final re-submission of RA to Journal B, accepted with no further changes required. Draft eight (D_8) was the published draft of the research article in the Journal B's website.

Written drafts were the products of two main components, the writing process (RQ1) and publishing process (RQ2). By looking at the texts in research question three (RQ3), I tried to weave the two components into each other in order to see the influence of all working components on the text. The writing process is the first component of the complex system that went under analysis.

Writing Process, a Main Component of the Complex System (RQ1)

(Research Question 1: How is the process of writing multidisciplinary multi-authored research article carried out by ESL authors?)

Research question one investigated the writing process as a main component and subsystem of the complex system of writing and publishing multidisciplinary

multi-authored research article. In this sub-system laboratory work and experiments, discussions, literature review, and several other processes resulted in production of five drafts of the article from initial conceptualization (D_0) to the production of the first complete draft (D_4) that was submitted to the first target journal (Journal A). The present research is a case study of a team of science researchers writing and publishing a research article from the beginning state to the end over a period of five months, from which it took researchers over three months to complete the writing process.

Although the main sources of data in the present study were the interviews with the researchers in different states of their research project, for the writing process other sources also helped in the triangulation of findings. Observations of the laboratory work, generated images, tables, texts and graphs, as well as discussions of multiple authors were some of the sources of data for this study. The themes were emergent from the data (see chapter 3 for processes of identifying the themes).

Among the five drafts produced in the writing process, draft zero (D_0) did not have a physical manifestation. Instead, D_0 provided the initial conceptualization of the research article, the necessary basis both for the whole research project and for the succeeding drafts of the article. In order to analyze the shaping process of D_0, the following section will focus on the main aspects which influenced the process of initial conceptualization of the research article.

Initial conditions of the complex system (draft zero). The initial conceptualization of the research article began with what I call draft zero (D_0). Draft zero constituted what Larsen-Freeman and Cameron (2008) refer to as "the initial conditions" for the complex system of writing and publishing a multidisciplinary multi-authored research article. Draft zero represented all the discussions and

preparations that the multiple authors had before their hands-on involvement in the research project. I have used the term "draft zero" because the draft did not exist as a written document. Instead it existed in the minds and real-life situations of researchers, in their discussions, in their past experiences of publication, and also in existing knowledge in the area of research. The themes of the initial conceptualization of RA emerged from interviewing multiple authors and observations of their discussions.

Despite draft zero did not have a physical manifestation, it was an important part of the whole "research process as a complex system" in providing the initial conditions for the system. The initial conditions of a complex system "control and drive" the whole system behavior (Larsen-Freeman & Cameron, 2008; Mercer, 2011; Morrison*, 2005). In other words, the entire research project was built on this very initial state in which three elements contributed to the genesis of the research project.

The research project had its genesis in three major influences namely the new grants offered by university; principal author's personal life experience; and the expertise of the researchers in their field. These are referred to as "elements" in complexity theory (Larsen-Freeman &Cameron, 2008, p. 27; Morrison, 2005). These elements emerged from the analysis of interviews with multiple authors of the research article. Figure 4.2 shows the three main elements which helped the principal author, Dr Janie, in idea generation for the research project in science.

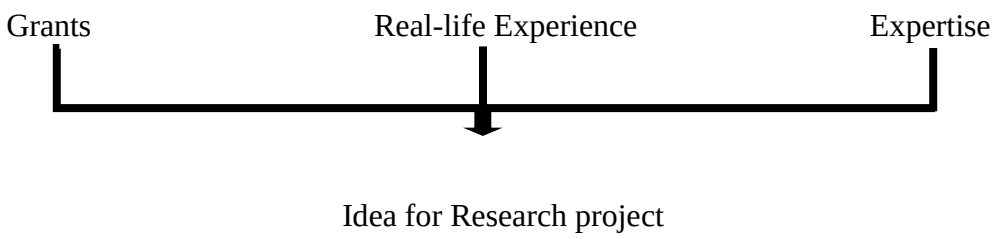

Figure 4.2. Elements of idea generation for research project

Two new grants. The availability of university grants provided the initial conditions for the research project. In a very early interview with Dr Janie, the principal author of the article, in response to the question "where did the idea of the project come from?" she stated "… the idea [for the research project] began when we discussed various topics that would be aligned to the two new grants offered by university".

The two new grants that Dr. Janie was referring to comprised a grant in environmental research which was beneficial to Malaysian environment, and another grant especially offered by the university, to encourage top-tier publications in order to enhance university ranking among other research universities in the region (South East Asia). By producing more research articles and conducting environmental research, researchers could benefit more from grants and funding. The role of funding and financial support in conducting research projects stimulates the willingness for producing knowledge in the form of research articles. In science disciplines, most of the times it is inevitable to conduct research collaboratively.

In order to receive the funding from these grants Dr Janie arranged a multidisciplinary team of researchers to conduct a research project leading to publication of their findings in the form of research article. The team involved eight researchers from three different disciplines whose laboratory work, writing, interactions, and discussions provided this study with rich real-life situations worth researching.

Since the main objective of one of the grants was to protect environment, researchers like Dr Janie were encouraged to organize environmental research

projects. Following excerpts from the interviews with Dr. Janie highlights how the grants motivated the research:

> …[The two new] grants mostly support local projects which are [beneficial to] national and international interests in environment, …[and] of course publication is very important for receiving the grants. It increases the ranking of our university … as a scientist I asked myself how can I help environment? …from my [past experiences in] environmental research, I had some ideas for further research. … I chose to work on decreasing toxins in Malaysia's natural waters … [it] also has use elsewhere in the world.
> (Interview with Dr Janie: Amid-D0)

The bigger idea was to protect the environment and Dr Janie picked on that idea by asking herself a simple question, "how can I help environment?" The result was a sub-idea generated in her mind. Dr Janie decided to help decrease the amount of toxic chemical Z_2 in natural waters by connecting her previous knowledge to the need for protection of environment.

Real-life experience. While the availability of university grants provided the impetus for initiating of the research, the actual framing of the project had its genesis in the prior real-life experiences of Dr. Janie, the principal investigator and eventually the principal author of the research article. The idea for the project began on a visit to a village several years ago. Dr. Janie talked about her real-life experience:

> … [Several] years ago I visited a kampong [=village (in Malay language)] with my family. We saw dead fish on the surface of water …in different parts of river and in ponds. We asked the people [for reason]…, they said water is poisonous in some parts due to waste

> water of nearby factories …and they complained about diseases causing by this matter… especially dangerous for children.
>
> (Interview with Dr Janie: Pre-D0 & Amid-D0)

This problem was not peculiar to that village; it is a problem that has implications for countries which are surrounded by natural waters. Scientists claim that natural waters are endangered by chemical pollutants from human activities and natural resources which contaminate the environment and food chain. Thus, the research projects which contributed to solving the environmental problems would benefit more from the grants provided for protection of local environment. Figure 4.3 pictures how Malaysia, a rapidly developing industrial country, is surrounded by natural waters.

Figure 4.3. Natural waters of Malaysia

Dr Janie linked her past real life experience of water pollution to the grant offered for protection of environment. This influenced her choice of topic for research and publication, as well as her arrangement of the research team. Based on the required expertise for conducting the research project in science, the team needed to be comprised of multi-disciplinary researchers from chemistry, physics, and engineering to organize the project.

Expertise. The expertise, which is the subject of discussion here, comprised all aspects of knowledge and experience retained by multidisciplinary co-authors of the research article. The researcher-authors took advantage of expertise in conducting the experimental and producing several drafts of the research article. Past experiences in the field, knowledge of the current literature, selection of the target journals, and co-authors' discussions were important components of expertise.

By focusing on the objectives of the new grant in environmental research and considering her real-life situation in the past, Dr Janie, the principal investigator, combined her rich experience from research and publication with studying huge number of current research in the field in order to find a gap in knowledge for her multi-disciplinary research project. Dr Janie explained:

> …now that I have this opportunity [of new grants] to help my people [in having clean water] I don't want to miss it…thorough reading a lot of recent studies about chemicals [which are] polluting [natural] water … specially [the studies about] the methods that other scientists have used so far for removing [toxins] from water …, I've decided to work on detection properties of XY_2.
> (Interviews with Dr. Janie: Amid-D0)

The complexity of the project, drawing on different disciplines, required the principal investigator, Dr. Janie, to form a team comprising different kinds of expertise. The three main disciplines that she needed for conducting the research project were chemistry, physics, and engineering. After Dr Janie reached a promising gap, she decided to initially discuss the topic with her two immediate colleagues in physical chemistry, Dr Nick and Prof Tony. Dr Nick was her husband and colleague from the same department and Prof Tony was her doctoral supervisor and colleague in another university. Dr Janie stated, "Having discussions with Prof. Tony and Dr Nick,

we all agreed on working on [toxin] Z_2 and the new-possible ways for removing it from water".

In the very first meeting of the three co-authors, Dr Janie talked about the scientific and experimental aspects of research project with her colleagues, Prof Tony and Dr Nick. First, she shared the information about the two new grants offered by university; one was to encourage environmental research, and the other focused on high impact publications. Then, she explained different aspects of the project including her review of related literature and existing gap, the experiences that the three of them had from collaborative projects in the past, and also about the rationale for choosing XY_2 and Z_2 as the main chemical elements for their project:

> … as you know, XY_2 has been widely used as a gas detector, but I couldn't find studies that show it [XY_2] detects [non-gas] elements such as [toxin] Z_2 … synthesis of a [type of] XY2 which can detect Z_2 [in aqueous condition] is new …we can fabricate XY_2 by [hydrothermal] method; it is environmental[ly] friendly…and [synthesis] can be done in enclosed condition in laboratory.
> (Observation of group discussion, Dr Janie, Prof Tony, &Dr Nick: Pre-D0)

In addition, journal selection and time span were among other issues discussed by the three co-authors. Dr. Janie had read the journal website; "based on the keywords" used in previous published articles which matched their article's keywords, she decided to submit their research article to this journal (in this study it is called Journal A). The journal was one of the prominent publishers in the field of chemistry and the synthesizing method that Dr. Janie and her team adapted for synthesis of XY_2 (hydrothermal method).

Regarding time span Dr. Janie, the principal author, explained that in their discipline "a research project and [publication of its reports] takes about three to five months". But, usually during the actual study there are several elements affecting this time-span. For instance, once one of the authors had to leave the country because he "had a conference to attend" and he postponed his laboratory work for one week because "the experiment was part of his [contribution to the] project".

After Dr Janie proposed the research project, Prof Tony and Dr Nick provided their thoughts and feedback. They raised several issues that needed to be considered before they could start the research project. The issues included:

- The arrangement of research team and the division of labor
- Authorship issues and writing RA drafts
- Equipping the laboratory and purchasing necessary materials
- Estimated time for conducting the project
- Funding

At the end of this meeting, Dr Janie and her two advisors, Prof Tony and Dr Nick, agreed on the whole project and on inviting other researchers to join the research team. Based on their discussions, they all agreed that they would necessarily need to use the expertise of engineers for one part of the study. In addition to discussions related to the research article text, other issues related to collaborative research project such as time span, division of labor, authorship, and publication were discussed too. The following excerpt is from the initial meeting of the three co-authors, Dr Janie, Prof Tony, and Dr Nick about setting the research team:

> Dr. Janie: …we should arrange the [research] team soon …any suggestions Prof. [Tony]?

Prof. Tony: my suggestion is [that]… we ask Prof. Zarimah [from engineering] and her colleagues [to help us] for voltammetry [of XY_2 particles]. I've worked with them in several projects… They're quite knowledgeable and fast.

Dr. Janie: …would you please contact them?

Prof. Tony: Sure. I was going to say… I'll contact Prof. Zarimah and will let you know.

Dr. Nick: for syntheses also Dr. Yang has already said he's ready for the new project.

Dr. Janie: Very good! …one of my [doctoral] students is also helping me [in laboratory] at the moment.

Dr. Nick: you mean Ken?

Dr. Janie: yes [Mr.] Ken. He's sharp… and we have worked in the lab together before. I trust his work [in the laboratory] it is quite good and accurate.

(Observation of group discussion, Dr Janie, Prof Tony, and Dr Nick: Amid-D0)

At this point the three researchers, Dr Janie, Prof Tony, and Dr. Nick, agreed on the subject and focus of their research project. Meanwhile they were aware that other researchers' expertise would be necessary for completing their multidisciplinary research project. As Dr Nick stated in an interview, "…in scientific research it is inevitable to ask other people for assistance". Likewise Dr Janie addressed the nature of scientific research as "cross-disciplinary" which "is more of exchanging knowledge among different disciplines". The assigned tasks, the decisions which were made, and the notes taken by co-authors in this very first meeting, became the basis for the succeeding processes in the research project.

After initial meetings with the faculty and her colleagues in physical chemistry, Dr. Janie set the first meeting with the whole team members or so called co-authors. She explained the new funding policies and the rationale for choosing the new topic

as well as each author's roles and responsibilities. Research team members asked several questions and commented on each other's ideas (see Appendix I for more information on the meeting). Among all, Mr. Ken (Dr Janie's doctoral student) was mostly silent; later in an interview he explained:

> …It is my first experience to work with several experts in a research project. I preferred to listen more …in order to learn more. This research is related to my own PhD study too. So I benefit [from it] too.
> (Interview with Mr. Ken: Pre-D1)

Despite the fact that Mr. Ken's name was not supposed to be included as co-author, he accepted to be part of the research team to assist his colleagues in the laboratory work and gain experience.

Due to the multi-disciplinary nature of the research project, Dr Janie arranged her team of researchers based on their expertise in research and publication. The original number of researchers in the team, as it is shown in Table 4.1, was eight. But, because of authorship issues which emerged during publishing process the published RA included only six names from the research team. These issues are elaborately discussed in the authorship section under research question two (RQ2). Table 4.1 shows each author's summarized profile including their expertise and number of publications.

Table 4.1

Research Team's Profile

N	Pseudonym& title	Specialization/Role	Selection	Publications (book/article)
1	Dr. Janie	Chemistry & Physics; material characterization : Main author-writer	Decision maker	30^{+}
2	Dr. Nick	Physics department: characterization, coauthor-writer, lab assistant	Co-author from previous projects	10^{+}
3	Prof. Tony	Chemistry: electrochemistry, coauthor-writer, Advisor	Dr Janie's doctoral supervisor; co-author from previous works	70^{+}
4	Dr. Yang	Chemistry: Coauthor, lab assistant	Co-author from previous works	10^{+}
5	Prof. Zarimah	Electrochemical Engineering: coauthor-writer, Voltammetry Advisor	Prof Tony's co-author from previous works	20^{+}
6	Dr. Harry	Electrochemical Engineering: coauthor, lab assistant, Voltammetry	Prof Tony's co-author from previous works	7^{+}
7	Dr. Lee	Electrochemical Engineering: coauthor, lab assistant, Voltammetry	Prof Tony's co-author from previous works	10^{+}
8	Mr. Ken	Chemistry: PhD candidate, lab assistant, synthesis	Dr Janie's doctoral student	1^{+}

Note. "+" means "more than" (e.g. 30^{+} means more than 30 articles were published by the author Dr. Janie)

Additionally, Table 4.1 highlights how each researcher joined the team and collaborated to the project. As an example, Dr Yang (number 4 in the above table) whose field of research was mostly in chemistry assisted the team in conducting the

experiments in the laboratory. Also, he had worked with Dr Janie in other projects before. Dr Yang's publication of more than ten research articles, by that time, was his additional positive point for being invited into the new project.

Since the research project was multidisciplinary, it required expertise from chemistry, physics, and engineering. Each researcher's expertise was crucial for the research project. Researchers contributed directly to the process of researching by their actions and interactions and also (in)directly to the written drafts of the research article. Thus the entire project and the text took their form because of each and every researcher's expertise.

Up to here three members of the research team, Dr Janie, Prof Tony, and Dr Nick, were already involved in the research project. All of them had a background in physical chemistry. Other researchers were invited to join the research team; three of them came from engineering, Prof Zarimah and her two assistants Dr Harry and Dr Lee; the other two researchers, both from chemistry background, were invited to assist the team mostly in the laboratory work; they were Dr Yang, laboratory assistant and Mr. Ken, Dr Janie's doctoral student in science. In the following more details about each researcher are given, since their background shaped their role in the research project and consequently influenced the text of research article.

Dr. Janie was the principal author of the research article. She was an award winning young scientist who had published over 30 ISI-cited journal articles, several proceedings, and some waiting for publication since she was a PhD student in chemistry. The papers that she had published were mostly multidisciplinary co-authored articles. Her past research was mainly sponsored by two Malaysian health and beauty companies. She was specialized in synthesizing graphene-based materials,

a type of carbon which has densely packed atoms. The way she synthesized these materials was unique. This was her inspiration for most of her experiments. In the science research project that is the subject of the present study, Dr Janie used "hydrothermal method" for synthesis of different types of XY_2. This method is a common way of chemical synthesis in science.

Dr Janie was also the main writer and editor of the RA text. She was the principal investigator, the research-team coordinator, first author in the list of authors, corresponding author, and also the decision maker.

Dr. Nick was an expert in physical chemistry, who had both publication experience and several years of work in the science lab. His relation with Dr Janie as husband-wife, and also co-working with her in several projects made him a physicist who also knows about chemistry experiments and publications. He worked with Dr Janie in the same department. They were assigned with several other projects too. In most projects Dr Janie benefited from his experience. Their frequent discussions while working in the same office helped both of them improve their knowledge. In the research project that I studied its whole process, Dr Nick assisted in laboratory, provided advice in the meetings, and dealt with providing materials for experiments. The principal author, Dr Janie, talks about Dr Nick by saying:

> …sometimes it is difficult to have your husband as your colleague [she smiles, as joking] I've learnt a lot from our discussions and even arguments that we had over scientific issues and methodology… I hope he also learned from our discussions.
> (Interview with Dr Janie: Pre-D1)

And it was mutually true for Dr Nick. Exchanging ideas and knowledge in multidisciplinary research could enhance their experience in research and publication. Dr Nick stated that:

> "[Dr] Janie is hard working …and she has good interaction with other scientists …whether in Malaysia or other part[s] of the world …her knowledge and experience made her a valuable colleague for me. We have worked in several projects before …our field is not exactly the same. I think that's why we learn from each other.
> (Interview with Dr Nick: Pre-D1)

Prof. Tony used to be Dr Janie's doctoral supervisor when she was doing her PhD in chemistry. He was the most senior and experienced researcher in the team. He had published more than 70 journal articles and about the same number waiting for publication. He had coauthored most of his articles with other scientists from various countries and disciplines. He was the senior advisor of the research team and helped in solving problems several times during research process. For the research project, Prof Tony provided advice on many different aspects including the processes of XY_2 synthesis, and Z_2 detection. Interviews with him revealed important details about the process of writing and publishing multi-authored RA. One "critical" issue mentioned by Prof Tony was the importance of timing about publication:

> …time is very critical in our field because… [for example] during one of my projects, I attended a conference and presented some of our important findings. Only two months later I saw our findings [which] were published by a research team from [another country]. Since our methodology [in experiments] was unique I knew that they had taken our ideas, and …it was my mistake because I didn't publish my findings immediately after that conference.
> (Interview with Prof Tony: Pre-D1)

Dr. Yang, who was Prof Tony's colleague in department of chemistry in another university in Malaysia, had coauthored articles both with Dr Janie and Prof Tony in the past. In the research project, he directed all the experiments in the laboratory and reported the results to the main author, Dr Janie. Dr Yang was following the research trend that Prof Tony had adapted. Assisting Prof Tony in laboratory had made him an experienced experimental researcher:

> I have [learnt] most of my knowledge in research from Prof Tony. He is my mentor…. The way he approaches research is fantastic. His perseverance [is great]… He plans his projects very accurately before he goes to the lab or touches anything! ... Everything has to be…[almost] perfect… the equipment, the quality of material, cleanliness of containers, and…
> (Interview with Dr Yang: Pre-D1)

Three other co-authors from engineering were invited to join the project because of the multi-disciplinary nature of the project. In the very first meeting with Dr Janie and Dr Nick, Prof Tony explained about the expert services that Prof Zarimah and her colleagues, Dr Harry and Dr Lee, provided for him in other projects. Therefore, the three engineers joined the research team after the team-coordinator, Dr Janie, decided to benefit from their expertise in the project. Among the three, Prof Zarimah was the most experienced researcher. Years of lecturing, authoring and coauthoring articles and books made her colleagues, Dr Harry and Dr Lee, become her long-time co-workers in the field.

Prof. Zarimah, an engineer-researcher who had previously published several co-authored articles with Prof Tony, was an expert in Voltammetry. She provided scientific service for scientists from other disciplines especially material sciences like

chemistry and physics. In addition to expertise, the accuracy of machines that Prof Zarimah and her colleagues used were among the reasons that scientists from other disciplines, including Dr Janie, needed to ask for their collaboration in cross-disciplinary projects. Chemists and physicists benefitted from Prof Zarimah's expertise in their multidisciplinary projects:

> … our work [in engineering] provides better conditions for other scientists to continue their work in different aspects. …they are not [any longer] limited to their own field. We give them… mostly, the results of our work. It helps them to decide on their next steps …sometimes the costs of experiments are so high that no researcher wants to take the expensive risk …to repeat a test several times. We help them take next steps wisely and…with confidence …this is actually the beauty of collaborative [multidisciplinary] research.
> (Interview with Prof Zarimah: Pre-D3)

Dr. Harry and **Dr. Lee** were Prof Zarimah's colleagues, who assisted her in the laboratory and co-authored papers with her in other studies in the past. Although each of them had their own specialties in engineering, they preferred to work collaboratively in a team of researcher-engineers under Prof Zarimah's expertise to benefit from each other's experiences and variety of knowledge in the field. Their collaborative research was rewarding since they stated "... in recent years we could publish more articles… this is our reward of working [together] and continuing collaboration".

Mr. Ken was a final-year doctoral student in physical chemistry under supervision of Dr Janie. He had worked as a research assistant in several research projects since his Master's degree. In this project Dr Janie suggested him to assist in the laboratory work while she had not promised to include his name as a co-author. Part of his PhD studies was related to "hydrothermal method" of material fabrication which was applied for this project too. Since the research project had a lot of new experiences for him to learn from several experienced researchers in the team, he preferred to join the project regardless of not being considered as one of the multiple authors. Although Mr. Ken's name did not appear in the list of authors of the published research article, his inputs to the article was not ignored or omitted from the data sets of the present study. Like other researchers he was also observed and interviewed whenever it was necessary.

The researchers' roles and contributions to the project depended on Dr Janie's decisions; she was the project manager and the principal author of the RA. She used the gap in knowledge as the basis for the research project on experimenting characteristics of XY_2 in detecting Z_2 in natural waters. First, the research team needed to synthesize a type of XY_2 in the laboratory which was suitable for detecting Z_2. Then, they had to test if the synthesized XY_2 could detect Z_2 in water. Authors, following the instructions of the main author, were doing their own parts in the research project which were assigned on the first meeting. Table 4.2 summarizes the multiple authors' works and contributions to the writing process.

Table 4.2

Researchers' Roles and Contributions

Authors	Roles and Contributions
Dr. Janie, Prof. Tony, Dr. Nick	Literature Review
Prof. Tony, Dr. Janie, Dr Nick	Providing material, machinery, contacts
3 engineering scholars and Mr. Ken under supervision of Dr. Janie	Laboratory work: doing the experiments, generating graphs and tables from findings
all authors	Sharing knowledge and information by: discussions inside laboratory, meetings outside laboratory, phone calls, SMS, chat and email, sticky notes, etc.
Dr. Janie (mostly), Prof. Tony (some parts)and Prof. Zarimah (engineering-related sections)	Writing tentative drafts, setting general frame for the article

The initial conceptualization of the research project catered to several aspects of the research article text including topic; title; list of authors; target journal(s); related literature; and the reference list. Co-authors' academic background and past experiences shaped the expertise which contributed to the researching process, including the production of drafts of the research article. The initial conditions of the complex system also provided scaffoldings for subsequent processes including synthesis of XY_2 (D_1), characterization of XY_2 particles (D_2), voltammetry of XY_2 particles (D_3), and writing the first complete draft of the research article (D_4). The elements or components which influenced the production of text are analyzed in the following sections of this chapter.

Hands on, "system commences the activity" (draft one). The initial conceptualization, which was discussed in the previous section, set the basis for the research team to commence the hands-on involvement in the research project by beginning the laboratory work. In other words, the complex system of writing and publishing multidisciplinary multi-authored science research article as a "system commences the activity" (Larsen-Freeman & Cameron, 2008, p.230) when the researchers commenced the laboratory work. Draft one (D1) reflected the results from several experiments in the laboratory during which researchers synthesized several samples of XY_2 particles. For conducting the experiments, in addition to the laboratory equipment, the team needed to have access to certain materials. The hands-on process of the research project started with purchasing the materials.

Materials, the elements of synthesis process. Materials were the crucial elements of the synthesis process and the research team needed to have access to them for commencing the laboratory work.

Dr Janie, the principal investigator of the research project, provided a list of necessary materials for Dr Nick who had the responsibility to provide the materials, since he had done this for other projects before. The list included several required specifications of each material which were needed for various experiments in the project.

Chemical-supplying companies produce different specifications (e.g. various percentage or number of atoms in one molecule) of the same chemical element for different purposes. Material suppliers and the varieties of chemical products are external components to the complex system. These components directly alter the result of experiments but indirectly influence the research article text, which reports

the results. In complex systems "sensitivity to the external" aspects results in "internal change" and it consequently changes the overall behavior of the system (Larsen-Freeman & Cameron, 2008; Morrison, 2005). An interview with Dr Nick who was in charge of providing materials for the experiments, illustrated the role of expertise in selecting and purchasing suitable materials as important components influencing the entire process of writing and publishing multi-authored research article:

> R (researcher): how do you provide your materials for experiments? Are they already provided in the laboratory?
> Dr Nick: …some [of them] we keep here [in the laboratory], but usually we don't keep all necessary materials in the lab, … for every new experiment we need to order necessary materials.
> R: order to where? To university?
> Dr Nick: It depends... Depending on [the] project, whether university provides the materials and equipment…or, …in most cases that we have a grant, we directly order to supplier or manufacturer.
> R: for this project how did you provide the materials?
> Dr Nick: …we purchased "X chloride"[pseudonym] and "solution" from A& B Chemicals [pseudonym], "acid"… and… "Soda chloride" [pseudonym] from Mars [pseudonym], three other materials from three different manufacturers.
> R: why did you purchase them from different places? What is the difference?
> Dr Nick: you know… [to] make it simple: it is like shopping clothes from different brands. For example Cat Active [pseudonym] is good at producing T-shirts especially for tennis players. For us, different companies produce different specifications or [different] qualities for many purposes… [and] for different usages.
> R: would you give an example from your materials for this project.
> Dr Nick: for example the "X chloride" [pseudonym] that we purchased from A& B Chemicals [pseudonym] has a higher

> percentage. Let me check…[he looks at a list on his table, which looks like the receipt from material provider]: Yes, it is… high… 98%. Other companies have it with different percentages that… [are] not suitable for our [present] project.
> (Interview with Dr Nick: Pre-D2)

An interesting finding from purchasing materials is that, while different specifications of chemical elements promptly determine the results of experiments, they indirectly change the interpretations of results in the research article text. Although the findings from laboratory works are mostly articulated as images, graphs, figures, and tables, the authors of science research articles need to interpret the findings in a written form. In other words, the complex system of writing and publishing multi-authored research article in science is sensitive to energy and matter (e.g. different types of chemicals) from outside the system (e.g. chemical suppliers). Dr Nick also stated:

> … to purchase chemicals [we] need to know our [project's] objectives and the suppliers who can provide what we [precisely] need, … [for example] another percentage of chemical X [(pseudonym)] is not suitable for this project.
> (Interview with Dr Nick: Pre-D2)

Interviews with Dr Nick, who was in charge of purchasing materials for the research project, revealed that, purchasing materials for science research requires expertise such as having the knowledge of "different types of materials and their specifications", being aware of the "objectives" of the research project, and also knowing various "suppliers" and being aware of the new chemical "products". Sometimes companies develop new types of materials which most researchers have

not used before. Also, being aware of other researchers' recent works facilitates the process of purchasing materials. Dr Nick said:

> I always have to keep [my knowledge] updated about the new products. … we need to read the suppliers' websites and [product] brochures, … also reading new research [in our field] helps us a lot for [taking our] next step. … that's why we ordered chemicals from [five different chemical suppliers].
> (Interview with Dr Nick: Pre-D1)

After the necessary chemicals where purchased from five different chemical suppliers (e.g. Merck), the team started the synthesis of XY_2 particles in the laboratory.

XY2 samples, "input to the system". The physical chemistry experts of the research team, including Dr. Janie, Prof Tony, and Mr. Ken, began synthesizing XY_2 samples in the laboratory. Through several experiments, which took about three weeks, four XY_2 samples were produced. For the research team who needed the results of synthesis for doing the forthcoming experiments, the produced XY_2 samples provided the "input to the system" (Larsen-Freeman & Cameron, 2008, p.95).

Every sample had its unique specifications with differing reaction time and concentration. In science research, each experiment takes place several times to ensure the quality and validity of findings. A table showing the parameters of samples and the size of XY_2 particles was produced (see Appendix G).

Four samples were produced and eight images were generated from the samples, showing each sample in two different dimensions; from which one image was in a larger scale bar in order to provide a better view of the synthesized XY_2 particles.

XY2 bulk, element of the synthesis process. After the XY_2 samples were synthesized in the laboratory, the scientists needed to examine which type(s) of the produced XY_2 had the potential to detect the toxin Z_2. In order to do the follow-up experiments the team needed to prepare XY_2 in bulk, another element of the system (Larsen-Freeman & Cameron, 2008, p.26) which contributed to the production of draft one (D1). By implementing precipitation method (formation of a solid in a solution) the research team could reach the bulk XY_2 powder which was yellow in color.

Although the results of the experiments were reflected under the draft one (D_1), only important procedures appeared later in the published RA in detail. In order for the readers of scientific papers to follow the steps of the conducted research, only the general process of experiments and their results are reported in the published article. The primary experiments are basis for other experiments. For instance, the synthesis of different types of XY_2 was a step for researchers to reach a certain shape which was more suitable for detecting Z_2 in aqueous condition.

System shift to characterization (draft two). In this stage of the research project, the system shifted into a new state called "characterization". Characterization is an experiment which enables scientists to scrutinize the internal structure and properties of materials by seeing the distribution of elements and their interactions.

In the previous stage, the research team synthesized several types of XY_2 particles. In order to find the most suitable XY_2 sample for detecting Z_2 in aqueous conditions, the team needed to analyze the shape, size, and general characterization of the synthesized XY_2 particles. Figure 4.4 shows a characterizer which helps scientists in the laboratory for the process of characterization; the research team could analyze the structure and characteristics of XY_2 particles using a chemical characterizer.

Figure 4.4. Characterization equipment

So the bulk XY_2 powder which was produced in the laboratory was characterized and scanning images were generated.

Scanning images, output components. The synthesized XY_2 particles in the previous stage provided the input for the research team to implement characterization. The output of characterization were the generated scanning images. The physical-chemists of the research team had both the expertise and equipment for characterization of XY_2 particles. To do so, they used a diffractometer, an equipment which employs X-ray for scanning the particles. After each scanning, an image was generated by a computer connected to the diffractometer. The images revealed the shape and construct of the particles and helped researchers in selecting the suitable XY_2 particle for detection of Z_2.

In this state of the research project, researchers' implementation of characterization was a connecting component between the synthesis of XY_2 particles and testing the capacity of particles for detecting Z_2. In the complex system of writing and publishing a multidisciplinary multi-authored research article these components

"mutually inform[ed] and determine[d] each other" via "cooperation, interdependence, and collaboration" (Morrison*, 2005).

Microscopic images of XY_2 particles were obtained from an X-ray diffractometer to help scientists study the structure of atom-size crystals. Only certain types of XY_2 had the highest detection-capacity among all other types for detecting Z_2 (a toxic chemical) in water. The ones with smoother surface had better potential for detecting Z_2 in aqueous condition. XY_2 had been used as a gas detector before, but the research team wanted to study if XY_2 particles could detect Z_2, which was a heavy metal. Results showed that XY_2 is a promising Z_2 detector in water.

All XY_2 particles were scanned and the scanning images were produced. The generated images were some of the products of the writing process for the draft two (D_2) of the research article. These images appeared later in the complete draft of the research article. Gallagher (2014) asserts that "multimodal texts stage encounters between and among composers and readers/viewers through the meaningful juxtaposition and combination of multiple modes" including "words, images, video, movement, and sound". Likewise, the generated images of XY_2 particles which were reflected in draft two (D_2) of the research article were components of the multimodal text.

By characterization, the researchers got to know the structure and shape of different XY_2 particles and select suitable types for testing their detection capacity in the next experiment. Therefore the selected XY_2 samples were sent to the engineers of the team for examining the detection capacity of each XY_2 sample through a process called voltammetry.

System shift to voltammetry (draft three). By sending the XY_2 samples to the engineers of the research team for voltammetry, the complex system shifted to a new state. The engineers had both the expertise and equipment for voltammetry of XY_2 particles. After characterization of different types of XY_2, the research team got to know the shape and construct of the suitable XY_2. Thus, they selected the most suitable XY_2 to study its capacity for detecting Z_2 in water.

Without voltammetry, which was a component of the complex system, the research team was not able to confirm that the selected XY_2 particles could detect Z_2 in water satisfactorily. For voltammetry the research project depended on the work of engineers. Dr. Janie, the principal investigator of the research team, explained why they had to use the engineers' expertise:

> … [Prof Zarimah's team] have the voltammetry [equipment] … and the knowledge to use the equipment for [extraction of] voltammograms. For the next step we need their work and [the] results from voltammetry. [That's why] there is [a] collaboration between us.
> (Interview with Dr Janie: Pre-D3)

Later, the head of engineers of the research team, Prof. Zarimah, explained the process of voltammetry and how their work contributed to the research project:

> [Current] research is cross-disciplinary. Not all equipment are available [for every single discipline]… especially in government institutions we have certain fund, we need to help each other or … [sometimes] we have to pay to private institutions to conduct one part of our research. They sell their services. Or we can rent their laboratories …or equipment.
> (Interview with Prof Zarimah: Pre-D4)

Prof Zarimah also added that "for the present project [their] expertise was the reason for collaboration, not the possession of equipment".

In addition to characterization, to examine the detection capacity of the XY_2 particles, the research team needed to conduct an experiment called *Voltammetry*, an electrochemical analysis in which chemicals are analyzed for their characteristics and behavior during chemical reactions.

Voltammograms, output components. Voltammetry is an experiment in which an electrochemical measurement takes place for analyzing the materials' characteristics and the results are presented in graphs called voltammograms. Figure 4.5 shows a voltammetry equipment.

Figure 4.5. Voltammetry equipment

The engineers of the research team conducted the voltammetry of the selected XY_2 particles with different concentrations. In the process of voltammetry, the accuracy of the equipment settings was of utmost importance. A small change in the equipment setting or in the implementation of the experiment could affect the whole voltammetry process including the generated voltammograms and the interpretations of voltammograms in the research article text. Researchers had to carefully watch and

check several aspects including the preparation of three electrodes, the extraction of oxygen from the voltammetry equipment before recording any voltammograms, and the temperature of voltammetric experiments (e.g. the temperature had to be between 23 to 27 ^{o} C).

The head of engineers, Prof Zarimah, stated that there were some "preconditions for conducting voltammetry" including the preparation of "three electrodes"; each playing a separate crucial role in the voltammetry of XY_2 particles. In the following, Prof Zarimah briefly explained how they prepared the main electrode for voltammetry:

> …before experimenting, the [glassy carbon] electrode was polished to [a] mirror-like appearance …with micro cloth pads … [and] rinsed with distilled water [thoroughly] between each polishing step.… [After all, it was] washed continually with [distilled] water and alcohol. …the [XY2] samples were introduced [to glassy carbon electrode] by tapping [the electrode] successively for 10 times onto the samples.
> (Interview with Prof Zarimah: Post-D3)

As Prof Zarimah mentioned, for doing the voltammetry experiment they washed the electrodes with water and alcohol after preparation, as it was the norm in their laboratory to do so. But, it seemed that the engineers' technique for preparing the electrodes was not suitable for voltammetry of the two new XY_2 samples, because they found a faulty result from their experiment. Prof Zarimah clarified how various components affected the process of voltammetry and consequently prolonged the overall time-span for completion of the research project: … [That's why] we cannot anticipate how long it takes to complete our [part of the] project and send the results to Dr Janie.

Later, the engineers resolved the problem the way it is explained in the following episode.

Technical problem and process of change. In the present study, the process of writing and publishing the multi-disciplinary multi-authored research article is viewed as a complex system. In a complex system that all components and elements are interdependently connected, "when things go wrong, they can go very wrong" (Giddens, 2013, p.162). In this episode Dr Harry, one of the engineers, encountered a "faulty result" from the voltammetry experiment. Later, by looking at the graph (voltammogram), Dr Harry described: The graph [generated] by computer [connected to the voltammetry machine] is not accurate. It is very similar to another group of chemicals [but not XY_2].

After seeing the faulty result, Dr Harry informed Prof Zarimah, head of the engineers, and asked her for a solution while emailing her the faulty results which were the generated voltammograms. After receiving and reviewing the voltammograms, Prof Zarimah decided to solve the problem first by studying the newest findings in the field. Prof Zarimah clarified:

> This [case] was different to me too. So I looked at the recent studies and found out where the problem was …In this specific type of equipment the electrode preparation must be very accurate…after [Dr] Harry informed me of a "faulty result", I looked at [several] recent studies to find a clue.
> (Interview with Prof Zarimah: Amid-D3)

Prof Zarimah's description of her review of related literature highlighted the interconnectivity among components of the complex system (Morrison, 2005) of writing and publishing a multidisciplinary multi-authored research article. Prof Zarimah continued:

> …while doing our work we usually re-check the results [several times] to make sure that our findings are reliable; …[we] also update our knowledge with the [most] recent studies to see what other scientists [in the field] are doing [in similar projects]; … their findings, … [and their] methods can help us a lot.
> (Interview with Prof Zarimah: Amid-D3)

From the review of the related and recent studies, Prof Zarimah found what she needed for resolving the problem. She found a recent study in which the authors had conducted a very similar voltammetry and reported interesting results. Prof Zarimah explained:

> …then I emailed one of the authors [of the article] and asked for their [creative] new technique [for voltammetry experiment] …and I found that for this experiment the electrodes must be cleaned and dried carefully. …So I asked [Dr] Harry to retry the experiment by drying the electrodes [by heating technique] after preparation.
> (Interview with Prof Zarimah: Amid-D3)

In the above episode the concept of unpredictable change, which is an important aspect of complex system's behavior, is highlighted when Prof Zarimah asserted "this was different to me too". Prof Zarimah emailed Dr Harry and explained the reason for the occurring problem. She attached the relevant study for his reference, and also asked him to change the cleaning technique for getting a valid graph (voltammogram). Prof Zarimah also continued, "we decided to repeat the experiment with a [slightly] new method, [heating the electrodes after preparation]".

In the complex system of writing and publishing a multidisciplinary multi-authored research article, in which the components are interconnected and interdependent, change in one component (e.g. a faulty graph) can make other components (e.g. preparation of electrodes) co-adopt to the new state of the system.

The change in the process of preparing electrodes influenced the results of voltammetry and the interpretations of voltammograms in the written. Connectedness is crucial to a complex system; it "exists everywhere" and it is an inseparable aspect of complexity (Larsen-Freeman & Cameron, 2008; Morrison, 2005). Figure 4.6 shows how a graph (voltammogram) as a component is connected to other components and is changed by them due to interconnectivity of all components in a complex system.

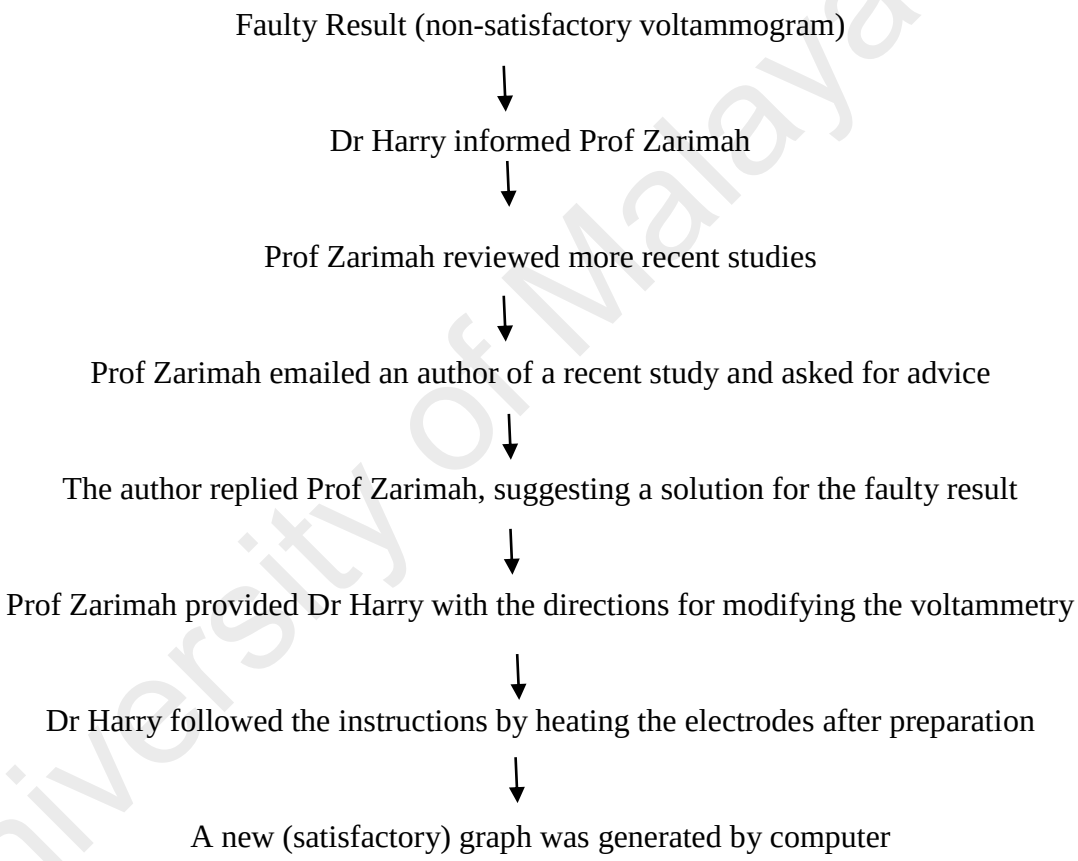

Figure 4.6. Interconnectivity of components in the complex system of writing and publishing a multi-authored science research article

As the results of the repeated experiment were different and a new graph was generated, the written draft (D_3) was also exposed to change consequently. Through the lens of complexity theory, change in one component influences other

interconnected components and the current state and behavior of the whole system. In researching a complex system when a focal component is observed, other components are still dynamically working and influencing each other, including the focal component. After the issue of "faulty result" was fixed, the engineers recorded the reliable voltammograms.

As soon as voltammetry experiments were completed, the produced voltammograms (graphs) of several XY_2 particles were prepared for interpretation. The research team discussed the results several times. Although the written draft (D_3) included all voltammograms, only some graphs were selected to appear in the final draft of the article submitted to the target journal for publication. It is also worth noting that some of the voltammograms were color-coded and the multiple authors of the article used colors for interpretation of voltammograms in the text. This is more elaborately discussed in analysis of the third research question (RQ3) of the present study.

The necessary experiments for the research project were done to this point of the research process and it was time for the researchers to start assembling all drafts for finalizing the complete research article for submission to their target journal.

First complete draft of research article (draft four). To this point of the writing process, the researchers had conducted several experiments including synthesis of the XY_2 particles and bulk XY_2 powder, characterization of the particles, and recorded the voltammograms; all of which resulted in production of drafts zero to three (i.e. D_0-D_3). To the team members, at this state the laboratory work was completed and it was time for them to report their findings by shaping the complete research article for publication.

Draft four (D_4) of the research article was the accumulation of the texts, graphs, tables, interpretations, data set, and other sorts of findings from experiments, discussions of the researchers, and laboratory work by the research team. In this section, the process through which the research team assembled all produced drafts of the article in order to produce the draft four (D_4) is described. It is further explained how various components of the complex system influenced each other.

Assembling produced drafts and shaping research article text. The principal author of the research team, Dr Janie, had the responsibility for putting all previous drafts together for shaping the article. She asserted that, besides fulfilling the "specific requirements" of their target journal, she formatted the article based on the famous conventional framework of IMRAD which refers to the main sections of a research article including Introduction, Method, Results and Discussion (Swales, 1990). Dr Janie explained:

> To write the [complete] draft for submission… we usually follow the convention…it is introduction first…our methodology or experiments that we have done …and… [then] results and discussions. But the final say depends on the journal …and [its] specific requirements.
>
> (Interview with Dr Janie: Amid-D4 & Post-D4)

Almost two weeks after the last experiment was conducted in the laboratory and the article was tentatively ready for submission, Dr Janie sent a soft copy to all co-authors of the article asking them "to provide any necessary changes to the text"; a multimodal text which included written text, images, graphs, and tables. According to Dr Janie, this could "enhance the quality of the paper whether in knowledge or in language". Meanwhile, Dr Janie took advantage of consulting her two immediate

colleagues, Prof Tony and Dr Nick. They had conversations on the phone or small talks in her office, discussing various issues such as formatting the text properly, authorship, and timing of submission to the journal. Dr Janie believed that "[all of] this helps me very much. [My colleagues] see it through a different lens that I couldn't notice before. The more we work on the paper … [the] less problem we would have for publication".

Co-authors' review of text. The principal author, Dr Janie, sent the complete draft of research article to the co-authors for final revision before submission to the journal. Except for one co-author, who was attending a conference, all authors returned the revised article to Dr Janie within a week. Each of the co-authors provided some revisions whether to the text or to the technical aspects of the research article. The suggestions which resulted in some changes to the text of the research article are later discussed elaborately under the analysis of research question three (RQ3). As Dr Janie, the principal author, needed the confirmation of all co-authors before submission of the article to the journal, she had to wait for that co-author to return the revised article while confirming the agreement for submission. Due to this incident, the submission of article to the journal delayed for another week.

Through the lens of complexity theory, the co-author who was on leave because of attending a conference and could not reply immediately, was a component of the complex system temporarily absent from the system and making the whole system to go into an unstable state (Figure 4.7, "b"); though the system's components had played their role in the previous state (Figure 4.7, "a") and completed the writing of draft four (D4). While "the system tend[ed] to move into a new attractor" (Larsen-Freeman & Cameron, 2008, p.50), the submission of draft four to Journal A (Figure 4.7, "c"), the authors had to wait until the co-author came back from his conference,

reviewed the article, and confirmed the submission of the final draft to the journal with the main author. This confirmation set the stage for submission of draft four (D4) to Journal A (Figure 4.7, "c"). Figure 4.7 represents the three different states of the complex system of writing and publishing a multidisciplinary multi-authored research article.

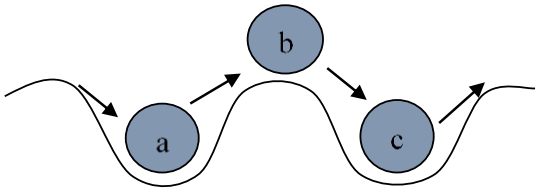

Figure 4.7. Three states of the complex system

Authorship issue changes the text. There is a comprehensive section discussing the authorship issues under the analysis of research question two (RQ2) of the present study. But, it is inevitable here to briefly elaborate on an authorship issue in the research team which occurred before submission of the complete research article to the journal. Another person to whom the complete article was sent for review was the head of department; since his confirmation was of utmost importance to the team. He was the person in charge for the allocation of funding for the research project. The principal investigator, Dr Janie, had to report the progress of their research project to the head of department regularly. Hence, she submitted a hard copy of the article to the head's office in addition to sending him a soft copy through email.

Within a week, after Dr Janie submitted the article to the head of department's office, she was asked to meet the head of department in order to discuss an issue. "I was shocked", Dr Janie said later, after she heard the head of department wanted Dr

Nick's name to be removed from the list of multiple authors. This was a shocking news to the whole team, since they all believed "Dr. Nick had a lot of contributions" to the research project and he "deserved authorship" of the article (from retrospective interviews with the research team). When Dr Janie was asked for the reason, she replied by saying:

> I …I… don't know. I really don't understand. He [, head of department,] says "because he [(Dr Nick)] is your husband you've just added his name to the list. He has no contribution to the paper"!
> It is not…not fair.
> (Interview with Dr Janie: Post-D4)

Thus, Dr Janie had no choice except removing Dr Nick's name from the list of co-authors of the research article. This authorship issue not only affected the submission process, also the text of research article was exposed to change; this is explained in detail under the analysis of text in research question three (RQ3).

After all revisions and suggestions from the co-authors were returned to Dr Janie, the main author, she completed the amendments and sent the article to two of her friends, who used to be her colleagues, for "a quick review" as she put it this way. Dr Janie, the main author of the research article said "I'm very careful about the accuracy of grammar and language …in general. [These] friends are [natives] English speakers from Australia and [the] UK. If they have time, they usually do it for me".

By sending the article to two native speakers of English who were also experts in science, the principal author, Dr Janie, wanted to "guarantee the correctness" of the written text before submission of the article to the journal. She also followed the target journal's drafting template in order to meet the criteria for submission of RA.

Considering all suggestions and amendments from people inside and outside of the research team, the principal author of the multiple-authored research article, Dr Janie, decided to put an end to the edition and revision process and sent the article to the target journal (Journal A). The submission of complete research article (RA) is elaborately discussed in the next section under the analysis of RQ2.

Summary of research question one (RQ1). By analyzing the writing process of a multidisciplinary multi-authored science research article, the first research question (RQ1) of this study scrutinized the processes through which the first five drafts of the article (D0-D4) were produced.

Draft zero (D_0) was the initial conceptualization of the research article, since it provided the initial conditions for the complex system of writing and publishing multi-authored research article.

Draft one (D_1) included the processes through which the research team synthesized XY_2 particles and then produced bulk XY_2 powder.

Draft two (D_2) displayed the characterization of XY_2 which resulted in production of scanning images. The images helped scientists in selection of suitable XY_2 particles which had the potential for detecting Z_2 in aqueous conditions and testing their potential in next stage called Voltammetry.

Draft three (D_3) had the recordings of voltammograms; the graphs which showed how the selected XY_2 particles successfully detected Z_2 in water and proved to the research team that XY_2 could be a reliable toxin (Z_2) detector.

Draft four (D_4) was the complete draft of the article that the multiple-authors produced by assembling all previous drafts (i.e. D_0-D_3) for submission to their target journal.

The text which was shaped during the production of different drafts of the article was re-shaped and re-written several times before the complete draft was submitted to Journal A.

The next research question (RQ2) is the continuation of the findings from the writing process (RQ1) regarding that the writing and publishing of the research article are interlinked processes and two main interconnected components of the complex system. The research question two (RQ2) of the present study attempts to explore the processes through which the written article by multiple authors got published in a journal. Based on the complexity theory, the system of writing and publishing the research article entered a new state when the authors submitted the first complete draft to Journal A.

The writing process merged into the publishing process when the first complete draft of the research article (D_4) was ready for submission to the journal. From this point, the complex system of writing and publishing multidisciplinary multi-authored research article entered a new state called publishing process. "When a complex system changes from one state to another, what changes is the nature of the activity of the system or its patterns of behavior" (Larsen-Freeman & Cameron, 2008, p.44).

As Dr Janie, the principal investigator of the research project indicated, the research team was "done with the laboratory work" and also prepared the "complete draft" for submission to Journal A. Therefore, to the research team no further experiments or laboratory work needed to be conducted; since processes of peer-review and edition were already implemented, the research article text was complete and ready to be submitted. Thus, it was time for the system to shift from one state (i.e. writing process) into a new state (i.e. publishing process) by commencing the

submission process. The second research question of the present study analyzes the publishing process through which the multi-authored multi-disciplinary research article got published in a journal. The products of publishing process were analyzed under research question three, while research question two (RQ2) scrutinized the process.

Complex System Transition to Publishing Process (RQ2)

(Research Question Two: How is the process of publishing multidisciplinary multi-authored research article carried out by ESL authors?)

In the present study, publishing process is regarded as a sub-system or a main component of the complex system of writing and publishing a multidisciplinary multi-authored science research article. Research question two investigated the publishing process as a subsystem in which submission of the first complete draft (D_4) of the article to the target journal (Journal A), modification of new drafts based on the feedback from the journals, authorship issues, and several other processes resulted in production of four additional drafts of the article; from the first accepted draft of the article by Journal B (D_5) to the last draft published in that journal (D_8). Research question two looks at the processes through which drafts five to eight (D5 - D8) were produced.

The present research is a case study of a team of multidisciplinary researchers writing and publishing a science research article from the beginning state to the end over a period of five months, from which it took researchers over two months to complete the publishing process. Thus the analysis of research question two starts with exploring the submission of first complete draft of the article (i.e. D_4) to the research team's first target journal (Journal A) and it ends when the article is finally

approved and published by another journal (Journal B). Journal selection process is discussed here to give a view for the selection criteria.

Journal selection, an initial condition. An important decision that the research team had to, initially, make was targeting journals for publishing their research article. The decision was part of the expertise and responsibilities of the researchers in the team. Selection of Journal A, as an initial condition, could influence the trajectory of the system and "form the system's landscape" (Larsen-Freeman & Cameron, 2008, p.230).

In conducting the research project, one of the primary goals of the research team was to publish their findings in a journal. According to interviews with the research team, from the initial stages of their project they were aware that they needed to "target several journals" in order to select one, to which they could submit their article for publication. As it was mentioned under RQ1, in the very first meeting of Dr Janie, the principal author, with the other two co-authors namely Prof Tony and Dr Nick, who were also the immediate colleagues to Dr Janie, the issue of journal selection was discussed too.

Dr Janie, the corresponding author, had to search for the journals which could be suitable for submission of their article for publication. The searching procedure included looking at the keywords which were already published in the journals; recently published articles in those journals; and the turn-over rate and number of issues per year.

Originally, there were four journals in the research team's "journal pool" (as Prof Tony called it by this term) and finally they chose one journal. The selection was based on the journal's scope and relevance to the research project, number of

publications in a year, accepted keywords, and the recent articles published in the journal. Later, Dr Janie who investigated the requirements, trends, and the scope of the leading journals in her field "selected [and targeted] one of the journals"; she also added:

> we must follow whatever the journal asks us to do….for example some journals ask for inclusion of authors' names… and year of publication in the [article] text when [we are] citing [the studies]… but others require numbering system [giving number in the text as citation and the same number appears in the reference list beside the authors' names]
> (Interview with Dr Janie: Amid-D0)

The processes of submission and resubmission of the drafts of the article are elaborately discussed in their own respective sections. The two journals that the research team dealt with in the publishing process are introduced here in order to give some information about how and why they were selected by the research team. To the request of multiple authors of the research article and in order to protect their intellectual property, in the present study the journals are given pseudonyms of "Journal A" and "Journal B".

Journal A. The first journal selected by the research team for publishing their article was Journal A (a pseudonym). One of Dr Janie's responsibilities was to search, find, and select a suitable journal for submission of the research article for publication. After Dr Janie found their research project fitting into the scope of Journal A she discussed the new project with her two immediate colleagues, Prof Tony and Dr Nick. Then they decided to commence the project while having Journal A as the first target journal for submission of their "paper".

Interviews with Dr Janie, the principal author, and Prof Tony, the most experienced researcher in the team, indicated that Journal A was one of the "prominent publishers" in the field of chemistry and specifically in "hydrothermal method"; the method that the research team applied in the synthesis of XY_2.

As Journal A was a journal that Dr Janie and her colleagues had not published any article in it before, they needed to study about the scope, acceptance criteria, publication turn-over, and other aspects which could help the research team in preparing the article for submission. For Dr Janie, Journal A, a tier one (Q1) journal in chemistry, was always a target wherein she was keen to publish her works. Dr Janie said:

> To me, Journal A [pseudonym] is always… [among] the top journals. It is Q1. The quality of its papers …new findings in chemistry …well-written reports, [etc]. For this project I think it [Journal A] is …it's the right place for publishing our paper.
> (Interview with Dr Janie: Post-D4)

After knowing about the title of selected journal (Journal A), I searched the title for obtaining more information about Journal A. The results of internet search for Journal A's title revealed that the journal was a Q1 journal (i.e. tier one in the international ranking of journals) at the time of submission.

Journal B. After the first submission of the research article failed and Journal A rejected the manuscript, the research team decided to submit the article to their second priority from their "journal pool"; it was Journal B (a pseudonym). Although Journal B was one of the leading publishers in electrochemistry, it was categorized under tier two (Q2) journals in the field of chemistry.

In the feedback from Journal A to the corresponding author, Dr Janie, the journal provided several hints for the authors of the research article that could enhance the quality of the article. The main author shared the feedbacks with the rest of the research team. Dr Janie asserted that "…the feedback from journal [(A)] helped us. For the next journal we will consider the revisions. My colleagues …will provide their suggestions too. The new draft will be different… in text and…. Slightly in lab work". Therefore, the new draft of article which was going to be submitted to Journal B was different from draft four (D4) which received rejection from Journal A.

Apart from journal selection, there were some authorship issues that influenced the publishing process of multidisciplinary multi-authored research article in science. Below, those authorship issues are discussed.

Authorship issues, components of publishing process. Authorship issues are among the most interesting and challenging findings of the present study. The influence of authorship, as a component of the complex system, is reflected on the content of the research article and on the entire research process as well. Since the main author, Dr Janie, had all the rights and responsibilities for the research project, she was the one who chose other co-authors and decided on the authorship and division of labor. When Dr Janie was asked how the other members of the team were selected, she explained "[First] each of them specializes in a different field, and… [second] I know them from last projects… or …I know them through Prof Tony".

The principal author preferred to arrange a team from researchers and colleagues she already knew from previous projects. This way, the "necessary expertise" for doing different parts of the project and having "less authorship problems" could be guaranteed for the principal investigator. Yet, the different nature

of the new project which required expertise of researchers from another discipline, made Dr Janie invite three other researchers from engineering background to join the research team.

In this section, three main issues in which multiple authors were concerned are discussed separately based on the author(s) involved. The co-authors Prof Zarimah, Dr Nick, and Mr. Ken were the focal points of each of these authorship issues. The findings highlighted the influence of authorship on the whole research process as a complex system including the research article text as a product-component.

Mr. Ken, system adaptability. From the beginning of the research project the research team comprised 8 researchers, but the published research article had only 6 names atop as multiple authors or owners of the text. This issue highlights that not all collaborators are co-authors. Mr. Ken was one of the researchers whose name was excluded from the list of authors.

From the initial stages of the project, Mr. Ken was aware that his name was not supposed to appear in the list of authors. He was a doctoral student of Dr Janie who invited him to assist in the laboratory work in order for him to gain more experience in the new project. In Mr. Ken's case, Dr Janie played two roles; one, as his supervisor and the other as the principal investigator-author. Dr Janie explained why Mr. Ken's name was not among co-authors and how she dealt with this issue:

> …from the beginning he [(Mr. Ken)] knew that his name was not going to be included. We discussed this matter before we start the work …sometimes we cannot have too many names as co-authors… journals want our profiles… having a PhD student in list of authors, sometimes…means… (for *some* journals of course)…eh…less quality. Yes, it …affects the acceptance procedure. But in very big projects it is accepted that we have even several students… even

> Masters' students. For [Mr.] Ken there may be no visible reward, …[but] he has learned a lot in this project.
> (Interview with Dr Janie: Post-D4)

The above excerpt emphasizes how different components such as publishing concerns influenced the authorship within the complex system of "writing and publishing multi-authored research article". Mr. Ken was informed from beginning that his contribution would not be acknowledged in the published research article as an author, assistant, or even collaborator. Hence, Mr. Ken's collaboration and assistance in the research project, while he knew that his name would not be included in the authors' list, gave rise to the adaptability of the system and its components to the new behavior. Although Mr. Ken received "no visible reward" for his work in the project, he gained a lot of experience; Mr. Ken said "…This project had a lot of new methods and techniques that I could never learn without being part of it". Without Mr. Ken's assistance in the laboratory, especially in synthesis of XY_2 particles, the direction of project could be different and consequently the research article text could be in a different form.

Dr. Nick, victim of control parameters. Another co-author whose name was dropped off the authors' list was Dr Nick; a researcher who was part of the team from the very early stages of the research project until the final draft of the research article was ready for submission. Dr Nick was considered as one of the main co-authors who had a lot of contributions to the research project. Some of his collaborations included providing materials for the experiments, providing consultations for Dr Janie and Prof Tony, and assisting in the laboratory work. Since in a complex system all components are interdependently related, without Dr Nick's efforts and contributions the direction

of research project and the process of writing and publishing the research article could be much different.

The omission of Dr Nick from the list of authors, despite his contributions, was due to the power of "control parameters" in a complex system; "the parameters that have particular influence around phase transitions" and "are the key to understanding change in complex systems" (Larsen-Freeman & Cameron, 2008, pp.53-54). Dr Nick's authorship issue was a shocking surprise for the whole research team. Dr Janie, the principal author, was fully aware of authorship issues due to her past experiences from co-authored articles and collaborative research; she did not expect such a "shock". The following excerpt is part of the interview with Dr Janie after she was asked to remove Dr Nick from the list of co-authors:

> …I cannot believe it, really I cannot take it anymore. Everyone knows he [(Dr Nick)] [has] contributed a lot to this paper. You saw that! …He [(head of department)] has asked me to withdraw [Dr] Nick's name! it's a shame, really it is.
> (Interview with Dr Janie: Post-D4)

Although Dr Janie, as principal investigator, was certain about including Dr Nick in the authors' list, towards the end of the project when the team wanted to submit the article to Journal A, one of the authorities who was in charge of the funding from the university grants, raised a serious authorship issue which finally resulted in withdrawing the name of Dr Nick from the list of multiple authors of the article.

According to Dr Janie the head of department believed that Dr Nick's name was included in the co-authors' list "just as a favor" to him; only due to family relationship (husband-wife) that he had with Dr Janie. When researcher asked Dr Janie

what she wanted to do about the issue, she answered "…we have no choice. It is …it is really a shame. We have to withdraw [Dr] Nick's name. Then we're allowed to submit the paper".

Finally, the research team could not convince the decision makers about Dr Nick's contributions to the project and Dr Nick's name was removed from the co-authors' list before submission of the article to Journal A. The concept of change in complex systems which causes emergence is obviously seen in this episode. Energy from outside of the system (the head of department's decision) influenced one component which was the authorship in publishing process of the article. This influence changed the number of co-authors. Another change imposed by the outside energy was a new section which was added to draft three (D3) of the article, acknowledging Dr Nick for his contributions to the project (read more about it in RQ3).

Prof Zarimah, system openness. Although the physical-chemistry researchers could have access to the voltammetry machine, they preferred to benefit from the expertise of the engineers, Prof Zarimah and her two assistants. The multidisciplinary research project, as a complex system, was open to "energy and matter" which could "come into the system from outside" (Larsen-Freeman & Cameron, 2008, p.31). The research project needed the expertise of researchers from chemistry, physics, and engineering. For engineering, Dr Janie decided to invite Prof Zarimah and her colleagues to join to the project. Their expertise and possession of one critical laboratory equipment, Voltammetry machine, was the main reason for including them as co-authors of the research article. Dr Janie, the principal author, described the situation by saying:

> ….[as] some equipment are found in other places [in other faculties, departments, or universities], and [our]department is not going to purchase more than one [equipment] from each type,… so we are encouraged to use other peoples' machines and facilities. … [We] end up using their experience in our project which is good and helps us … but we [will] have a longer list of co-authors.
> (Interview with Dr Janie: Amid-D2)

Dr Janie was obliged by the multidisciplinary nature of the project to use the engineers' expertise in her research team. Prof Zarimah and her colleagues provided expert services for the research project and the results of their work appeared as part of the research article.

According to Burgoine et al. (2011) "publication process would be much smoother if authorship and author order is discussed in advance". "The deal" between Dr Janie and Prof Zarimah was to include Prof Zarimah and her colleagues in the list of multiple authors of the research article. In return the engineers contributed to the project by providing their expertise for an important part of the experiments. Their collaboration not only had impact on the research project, also on the drafts of research article. The new trends in multidisciplinary research have changed the concept of authorship. To Prof Zarimah, the head of engineers of the research team "…almost all science research is now cross-disciplinary … [because] different disciplines help each other now to produce new knowledge …faster and more comprehensive[ly]". Due to multidisciplinary nature of research, even the audience of these texts becomes more knowledgeable. These types of studies provide their readers a broader view of existing knowledge compared to the readers of single-disciplined texts.

The authorship issues which influenced the publishing process consequently changed the text of the article in a way that the final submitted draft to Journal A had only 6 names atop it as the multiple authors of the research article. Table 4.3 shows the final list of co-authors of the research article in the order they appeared atop of the research article (you can compare this list of authors with the preliminary list of the researchers provided in Chapter Three of this thesis).

Table 4.3

Finalized List of Authors

Authorship Order	**Authors**
1	Dr Janie
2	Prof Tony
3	Dr Yang
4	Prof Zarimah
5	Dr Harry
6	Dr Lee

Submission process, point of transition. The text which was produced in the writing process, was ready for submission to the team's target journal in order to be published. The submission process was the system's point of transition from writing process, as a sub-system, to publishing process, as another sub-system.

After the research team completed all the experiments and laboratory works, they assembled the previous drafts in order to shape the final draft of research article (D_4) for submission to Journal A. The text was shaped and re-shaped frequently during

the production of different drafts of the article before the complete draft was submitted to Journal A.

The principal author, Dr Janie, who had already studied Journal A's website and was aware of the journal's scope, requirements, and the procedures for submission, sent the article to Journal A. Along with the article, the required forms including the authors' order and ethical issues were submitted to the journal as well. Since Dr Janie had experiences in refereeing for several journals, she knew about the general process of manuscript assessment by journals. Dr Janie explained:

> Usually journals …first, check the abstract for relevance, and then they proceed to the complete draft. It has several stages. Referees and editors have different roles. The editors check the essential criteria. …if met, then they send it to referees. If referees reject the manuscript …most probably editor will reject it [too].
> (Interview with Dr Janie: Post-D4)

According to Dr Janie's explanations, after an article is submitted to a journal it takes one of the two main directions. If the "manuscript" does not meet the journal's criteria it will be rejected on the spot and returned to the author(s) by the journal's editor informing them of rejection. But, if the manuscript meets the initial criteria for publication, the editor forwards it to the journal's referees for further review. Figure4.8 illustrates the two possible directions that a submitted article may take.

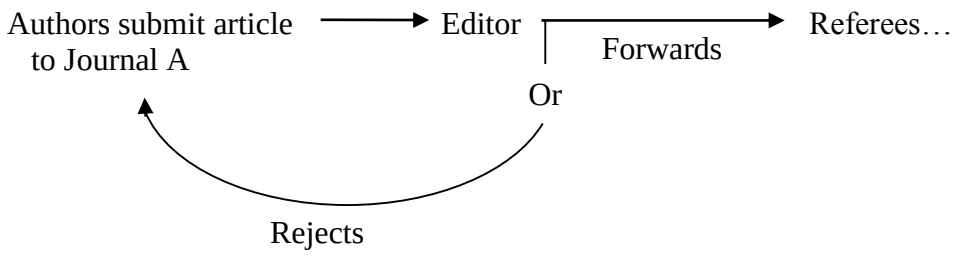

Figure 4.8. Procedures after submission of RA draft to journal

The research team submitted the first final draft of research article to Journal A. Although during waiting time for receiving feedback from Journal A the team did not need to do anything but waiting for the reply from the journal, the principal author Dr Janie and her two colleagues, Prof Tony and Dr Nick discussed the possibility of rejection. They were prepared for submitting the article to another journal because of their past experiences in publication:

> …publication [of articles] is not easy at all. We [have] had several rejections…years of experience [has] taught us a lesson …that we must continue until our paper is published. We should be patient and …prepared for [the] next step. …you can't give up in between.
> (Group discussion of Dr Janie, Prof Tony, and Dr Nick: Post-D4)

Submission of the research article to Journal A, in addition to being the point of transition, is a perfect example of nested subsystems within the main system of writing and publishing the multi-authored research article. "The components of a system may themselves be processes or systems leading to complex systems nested within complex systems descending at various levels … [and contributing to the] larger complex systems" (Mercer, 2011).

Draft four (D4) rejected. Almost three weeks after the submission of the article to Journal A, the team received a reply from the journal. The email included the decision made by the journal on rejection of the article along with several comments on the issues which caused the rejection of manuscript. The comments highlighted both technical-experimental issues and drafting of the research article text. Figure 4.9 is an excerpt from the opening part of the email that Journal A's editor sent to Dr.

Janie, the corresponding author, in order to inform her of their decision on rejection of the article (the complete email is given in Appendix F).

> Dear Dr. Janie,
> I regret to inform you that the reviewer of your manuscript has advised against publication, and I must therefore reject it. You have the right to appeal if the decision made by editor is regarded as unfair to you.…

Figure 4.9. Rejection of manuscript by Journal A

According to Dr Nick, one of the physical-chemistry experts of the team, there are mainly two types of comments on the articles which journals return to the authors. Figure 4.10 shows the two main categories of revisions that are "generally required by journals when articles are [either] accepted or rejected".

Although the research team expected that their article could be published in Journal A, surprisingly they faced rejection of the manuscript. Dr Janie believed that draft four (D_4) which was rejected by Journal A "could meet the standards" of the journal and be accepted, but because "…a lot [of articles] are submitted to top journals, they cannot accept all. …sometimes journals prefer to publish very top …perfect papers …they become very choosy and prefer not to be patient".

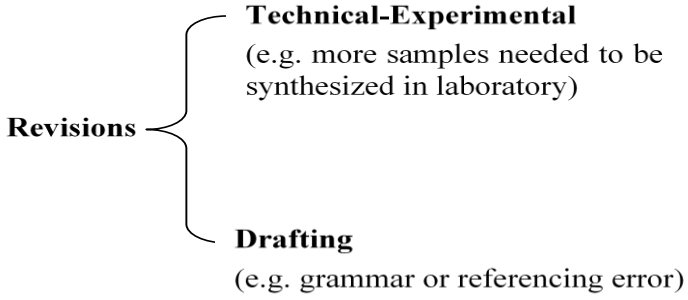

Figure 4.10. Two major revisions required by journals (according to Dr Nick)

The journals' criteria for publication of manuscripts are always exposed to change as they prefer to cater to higher levels of publication. Therefore, leading journals impose their power by determining the definition of "major" or "minor" revision. According to Prof Tony, they were "very lucky" to receive such comprehensive comments from the journal which rejected their article. Usually journal editors do not spend much time on rejected manuscripts:

> …it is not so good to be rejected …after all the efforts and works that we have done… but it is quite good [to receive useful comments from journal]. They provided very good, valid …helpful comments. Usually, editors are not so patient to give comments for rejection of a paper.
> (Interview with Prof Tony: Pre-D5)

When Dr Janie was asked to what extent and how a rejection like that could influence their next steps, she said:

> … eh… yes, [we are] kind of disappointed, but …not shocked. … We always learn more from rejections than from acceptance. It shows our weak points, especially this one. They have raised technical issues, writing problems… also their suggestion for improving the paper is very useful. We will use the comments for the other journal, [Journal B].
> (Interview with Dr Janie: Pre-D5)

Another interesting finding from the rejection of the article was that, the research team anticipated the rejection of their article by Journal A before submission to Journal A. They considered several journals as backup for resubmission of their research article:

> …since this is not [the] first time we get rejection from a journal, we are not shocked or panicked, especially in projects that several [multidisciplinary]researchers are involved …and we have a lot of resources. From our last experiences [in publishing research articles] we know other journals too.
> (Interview with Dr Janie: Pre-D5)

Immediately after receiving the rejection from Journal A, Dr Janie, the principal author of the article, discussed the matter with her two immediate colleagues, Dr Nick (her colleague and husband) and Prof Tony (her co-author from past research projects and also her doctoral supervisor). Although the research team had the right to appeal to the Journal A's editor for the rejection of their manuscript (according to the reply from Journal A's editor), they agreed on re-submission of the article to another journal rather than appealing to Journal A. Therefore the research team decided to make several changes to the article before they resubmit the article to their second target journal, Journal B.

The notion of "nested subsystems" within a complex system (Mercer, 2013) is highlighted under the rejection of draft four (D_4); because the rejection took place during the publishing process, as a subsystem of the "writing and publishing process of the multi-authored research article". The research team submitted the article to Journal A; the journal's editor decided that the article met the initial criteria; thus the article was forwarded to the referees for further evaluation. But, to the referees, the article did not satisfactorily fulfill all requirements of the journal. So, they returned the manuscript to the editor advising "against publication" of the article in Journal A. Finally, the editor informed the research team of rejection of their manuscript. Figure4.11 displays this subsystem within the publishing process.

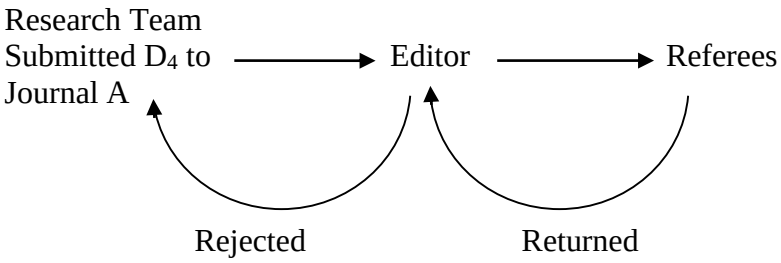

Figure4.11. Rejection, a nested subsystem within publishing process

Comments and feedback from Journal A (the journal which rejected the multi-authored research article) represented the energy and matter from outside the complex system. This energy triggered a set of changes in components of the system and consequently changed the whole behavior and product of the complex system, the text. Re-submission required producing a new draft. The comments from Journal A and the discussion of multiple authors were the base for production of a new draft (D_5).

Some changes needed to be made on the text and some were related to technical-experimental work. For example, when researchers found out that the number of synthesized (XY_2) samples were not enough for them to make strong statements about their research findings, they conducted more laboratory work and synthesized two more samples to increase the validity of their findings. Table 4.4 provides some examples of how the comments from Journal A worked as energy from outside the system and made changes to the system components and behavior.

Table 4.4

Energy and matter from outside system

Energy (Journals' comments)	Change
Samples are not sufficient	Research team synthesized two more samples
Experimental procedure is not correctly conducted and Described	Changes took place in experimental such as heating the electrodes,…; the description of voltammograms was enhanced by Prof. Zarimah, the head of engineers
Discussion and conclusions are not based on sufficient data	The two new samples provided sufficient data for Dr Janie to enrich the discussion of findings in the article
Figure 666 could be labeled better	The figure was renamed accordingly within the article (D5)

First re-submission of research article (draft five). After Journal A rejected the draft four of the article (D_4), the research team decided to resubmit the article to their second priority, Journal B. To do so, the authors had to make sure that the article met the requirements of the new journal (Journal B). Dr Janie, who was in charge of the submission of manuscripts to journals, took the initial step. She studied Journal B's website. Dr Janie explained:

> …the scope of the journal [(Journal B)] is the first thing that I usually check. If our paper is within the journal ['s] scope …then I study the requirements, [and] check the template… All I need, can be found in the [journal] website.
> (Interview with Dr Janie: Post-D5)

Studying Journal B's website helped the principal author in producing draft five, for instance in modifying the article format to match the journal's template. This

was one of the changes that the team made to draft four (D_4) in the process of producing draft five (D_5). In producing draft five (D_5), in addition to reflecting Journal B's requirements, the authors also used Journal A's comments on the rejected D_4.

Based on Journal B's requirements for submission of manuscripts and also the comments and feedback received from Journal A the principal author prepared a new draft (D_5) and sent it to other co-authors for review. After about a week that the necessary changes were made to the text, the authors agreed to re-submit the finalized draft (D_5) to Journal B. Therefore the first re-submission of the article took place when Dr. Janie, the corresponding author of the research article, submitted the draft five of the article (D_5) to Journal B.

Draft five (D5) conditionally accepted by journal B. After about three weeks the principal author, Dr. Janie, received an email from Journal B informing her that the research article was accepted for publication in the journal, subject to some revisions. The revisions included textual amendments and technical-experimental implementations. While having to revise the text, the research team was required to produce two more XY_2 samples in order to strongly prove their claim on potential of XY_2 in detecting Z_2 in aqueous conditions. The production of the two new XY_2 samples required laboratory work and linking the findings and descriptions to the previous drafts. Dr Janie said "good news is [that] they have accepted our paper...but we still need to spend more time [for] preparing new samples …and re-doing the whole analysis… writing again, revising again…", (Interview with Prof Tony: Pre-D6).

The research article was accepted conditionally because to Journal B "the amount of data" was not sufficient to support the claims that the research team had

made. Meanwhile, the text needed to be changed too. If an article is accepted by a journal for publication it does not guarantee the publication of the article. It all depends on how the author(s) fulfil the requirements of the journal, regarding the appointed revisions. Thus, the research team commenced the laboratory work immediately for synthesis of two more XY_2 samples and preparing a new draft of the article (D_6) for re-submission to Journal B.

Second re-submission of research article (draft six). Since Journal B required the research team to produce two more XY_2 samples, all members of the research team were engaged in the process of production of the new samples as well as a new draft based on the new findings.

Despite one of the main reasons that Journal A rejected the article was the insufficiency of XY_2 samples, the research team had decided to re-submit the article (D5) to Journal B without synthesizing new samples. But, interestingly, Journal B pointed out the insufficiency of samples as well; Journal B did not reject the article, instead asked the authors to do several changes in the text and provide more findings as well. The principal author, Dr Janie, said "luckily they [, Journal B,] did not reject the paper [unlike Journal A] but asked for more findings. [It] seems we *must* have two more XY_2 [samples]".

Apart from necessary amendments to the text, the research team had to undertake more experiments in the laboratory in order to produce two more XY_2 samples, followed by enhanced interpretations for the graphs, charts, and images which would link the new findings to the previous drafts. When journal B required two more XY_2 samples, the researchers had to go through the same processes of synthesis, characterization, and voltammetry which they had gone before for the

previous samples. But the new samples required a different method of synthesis. Therefore, the research team sought help from people outside the team. In the following an episode which shows the influence of energy from outside the complex system is discussed.

Consulting overseas expert. After receiving feedback from Journal B, the team decided to synthesize two more XY_2 samples. But according to Dr Janie, the principal investigator, there were some uncertainties in producing new samples. After discussions between two of the researcher-authors, Prof Tony and Dr Janie, they decided to consult with an overseas professor before synthesizing the two new XY_2 samples. Later, Dr Janie explained why they needed to discuss the matter with an overseas expert. She said "we are not [so] sure that our technique is suitable for [synthesizing] the new samples. …Prof [Tony] is going to discuss it with his colleague [overseas]. …We prefer more reliable results [rather than receiving more revisions from Journal B]" (from an Interview with Dr Janie: Pre-D6).

Prof Tony, the most experienced researcher in the team, contacted an overseas expert who used to cooperate with him in the past research. They discussed the synthesis of the new XY_2 samples which Journal B had required the research team to add to their findings. The expert provided some hints by suggesting the team to synthesize the new samples in absence of a solution (NH_3). Prof Tony explained:

> …there are a number of methods [for synthesizing XY_2 particles] among which "hydrothermal" method is preferred for us …[due to] simplicity, controllability, [favorable] grain size, morphology, and the [degree] of crystallinity. This hint [that the overseas professor suggested] was a great help in [modifying] experimental parameters. (Interview with Prof Tony: Pre-D6)

After discussing with the overseas expert, Prof Tony informed Dr Janie about the results of their discussion regarding the suggested method for synthesis of the new samples. Accordingly, the research team decided to synthesize the new XY_2 samples by using the suggested method. Thus the research team could get better results by changing the experimental parameters.

Change in synthesis process. As the overseas expert recommended, the two new XY_2 samples were synthesized in absence of NH_3 solution; this solution was used for synthesizing the previous four samples. According to Dr Janie the instructions and suggestions made by the overseas professor "facilitated" the process of production of the "two extra samples". The researchers took the suggested approach in producing the two new samples; they could reach a satisfactory point where new findings "seemed to be reliable". The twist in the process of synthesis resulted in production of two new XY_2 samples named as C1 and C2. The new samples displayed irregular form and structure and had rougher surfaces compared to the previous samples A1, A2, B1, and B2 (Appendix H).

In production of the new draft for submission to Journal B, the part of text which was related to the work of engineers (Voltammetry) had to be amended too. According to Dr Janie, the principal author, Journal B's comment on the description of Voltammetry was on "the way it was written" or the genre of the written text. The authors had to follow the genre accepted by Journal B for writing the description of Voltammograms. In the following, this genre issue is discussed.

Genre issue. Genre knowledge is a component of writing, especially of an academic text. In the present study writing process is considered as a component of the complex system of writing and publishing a multidisciplinary multi-authored

science research article. Thus, genre knowledge is one of the components of this complex system.

During writing and publishing process, there were times that the researcher-authors had to consider the "publication criteria" of the target journals in order to make sure that their article would be "publishable" (as Dr Janie stated). For instance, the way Prof Zarimah (head of engineers) reported the procedure of Voltammetry and interpreted the voltammograms were not satisfactory to the principal author; Dr Janie stated "…because the way voltammograms are interpreted [in the text] is not accepted by Journal B. I asked Prof [Zarimah] to look at some papers in Journal [B]. …they are good samples for the accepted papers ['criteria]", (Interview with Dr Janie: Pre-D7).

Later Dr Janie sent some articles, published in Journal B, to Prof Zarimah in order for Prof Zarimah to have a better vision of the journal's acceptance criteria for "interpretation of voltammograms" within the research article text. Following that, Prof Zarimah re-wrote the interpretations of the voltammograms and re-sent to the principal author, Dr Janie. This shaping and re-shaping of the text was an inseparable part of the writing process and took place many times during production of several drafts of the multidisciplinary research article by its multiple authors.

Prof Zarimah had published many articles before and she was aware of the accepted genre in writing science research articles, but she seemed not to be fully aware of the "interactional patterns" (Duff, 2010) within a specific genre, required by Journal B. This finding highlights that not only the genre knowledge is crucial for writers of research articles, they also need to master the knowledge of layers of genres within a specific genre in order to produce "publishable" papers.

When the new findings from synthesis of the two XY_2 samples emerged, the authors generated new graphs and additional tables and interpretations (this will be discussed more under RQ3). Dr Janie wrote a tentative draft based on the new findings, linking them to the previous ones. She also discussed with Prof Tony about the necessary changes to the text. By linking the previous texts to Prof Tony's opinions, Dr Janie wrote the finalized D_6 and sent it to all co-authors for final review before submission of the article to Journal B. As Dr Janie said, she also had to "re-check" Journal B's requirements for submission of their article, "in case [she] has missed" some requirements. When the multiple authors of the article agreed on the final draft, Dr Janie re-submitted the article (D_6) by emailing the manuscript to Journal B. Figure 4. 12 summarizes the production of draft six (D6) and the new input to the complex system which was provided by synthesis of two more samples.

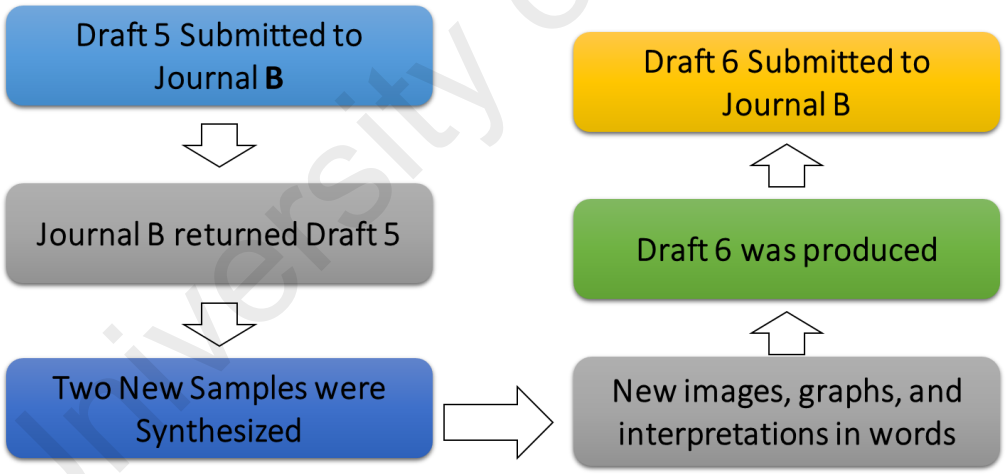

Figure 4.12. Production of draft six (D6) and the two new samples

Draft six (D6) returned for final revisions. After the submission of the article to Journal B, it was returned for some revisions for the second time. This time manuscript (D_6) was returned because there were still minimal changes needed to be done to the text. Additionally, Journal B commented that the new samples had

"enriched" the findings and better supported the "claims" that the research team had made. Therefore, the research team had to produce a new draft (D_7) for resubmission of article to Journal B, considering final revisions. The research article was taking its complete shape.

Third re-submission of research article (draft seven). When draft six (D_6) was returned to the research team, the principal author informed the other researchers about the recent revisions. There were three changes needed to be applied for production of draft seven (D_7). Dr Janie resolved the occurred textual problems and reflected the required changes in the manuscript. Then she sent the revised article to the team members and asked them to assist in final editing and revising of the article. Except for one minor comment from Prof Tony, the other co-authors made no more changes to the draft and agreed on re-submission of the manuscript to Journal B. Totally, multiple-authors made four changes to the text of draft six (D_6) and produced draft seven (D_7) for final submission to Journal B (all changes to drafts of the article are analyzed under research question three).

Published research article (draft eight). About two weeks after the corresponding author of the multi-authored research article submitted the draft seven (D_7) manuscript to Journal B, she received an email from the journal. Dr Janie said, Journal B notified her that the submission "process was complete" and the article was fully "accepted for publication". No further revisions were required to be done on the manuscript and it would be "published in the [next] issue of the journal". Since then, the multiple authors had only to wait for the article to be published in Journal B's website. In this stage, the complex system of writing and publishing multi-authored research article entered "a fixed point attractor, [where] it eventually settle[d] into a

single mode of behavior or stop[ed] altogether" (Larsen-Freeman & Cameron, 2008, pp. 57).

After the research team was notified that draft seven (D_7) was fully accepted for publication, the multi-authored research article (D_8) got published in the next issue of Journal B. Draft eight (D_8) was the published version of draft seven (D_7) in which extra information about the journal, including the journal's title, issue, and volume could be found.

Summary of research question two (RQ2). Research question two (RQ2) of the present study investigated the publishing process of a multidisciplinary multi-authored science research article from submission of the article to the first target journal (Journal A) to resubmission of the article to the second target journal (Journal B);and finally to publication of the research article in Journal B. During the publishing process the research team produced several drafts of the article:

Draft five (D_5) was the first resubmission of the research article to the team's second target journal, Journal B.

Draft six (D_6) was the second resubmission of research article to Journal B, after the team revised the previous draft (D_5) based on the requirements of the journal.

Draft seven (D_7) was the final resubmission of the research article to Journal B for publication.

Draft eight (D_8) had the same content as draft seven (D_7) except that draft eight was published in Journal B within the journal's template.

An interesting finding from the publishing process was the emergence of certain patterns within the dynamic complex system of writing and publishing

multidisciplinary multi-authored science research article. According to the complexity theorists, complex systems are unpredictable. Therefore, the system's behavior and interactions among and between the components and agents of the system could not be predicted until the interaction or behavior took place. But some of the findings of the present study display abundant predictability within the ever-changing dynamic system. The processes of submission of the article to the two target journals (Journal A and Journal B) and the sub-processes within each submission were some of those patterns reflected in figures 4.8, 4.10, and 4.11 of the present thesis. During these processes and even before any occurrence of revision, the researcher-authors were aware of the possibilities of receiving acceptance, rejection, or further revisions from the journal. But still, for the multiple authors of the article it was not completely possible to predict the details of the journals' response after each time of (re-)submitting the manuscript. This indicates that, while some aspects of the system are predictable in the form of macro-level patterns, the emergence of micro-level interactions and behaviors still retain unpredictability.

The first two research questions of this study looked at the writing process (RQ1) and publishing process (RQ2), the processes through which the team of multidisciplinary researchers conducted the research project and produced the drafts (D_0 to D_8) of the research article. By scrutinizing the nine produced drafts, research question (RQ3) analyzes the text of research article which was produced from the initial conceptualization (D_0) to the published research article (D_8) during the writing and publishing processes of the multidisciplinary multi-authored research article in science.

Text, Product-Component of Complex System (RQ3)

(Research Question 3:"How is the text shaped in the process of writing and publishing multidisciplinary multi-authored research article?")

Research question three analyzes the drafts of the research article produced in writing and publishing processes. In this case study of a team of science researchers writing and publishing a research article, the drafts of the article are viewed as product-components of the "complex system of writing and publishing process of a multidisciplinary multi-authored research article". Being interrelated to other components of the system, the drafts of the article were shaped and re-shaped during the writing (RQ1) and publishing (RQ2) processes as two main subsystems. In answering RQ3 Grabe and Kaplan's (1996) model of "parameters involved in writing" served the researcher in analyzing drafts of the research article, in addition to using complexity theory (adapted from Larsen-Freeman & Cameron, 2008). In this research question, the produced drafts of research article are analyzed in the following order.

-D_0: initial formation of the research article

-D_1: synthesis of XY_2 particles

-D_2: characterization of XY_2 particles

-D_3: XY_2 particles successfully detect Z_2 using voltammetry

-D_4: complete draft of article submitted to Journal A

-D_5: research article was re-submitted to a new journal, Journal B

-D_6: research article was improved and re-submitted to Journal B

-D_7: research article was re-submitted to Journal B for the last time

-D_8: research article was finally published in Journal B

For research question three (RQ3), segments of the produced drafts of the multi-authored article are displayed in forms of text, tables, and figures. It is tried to keep the intellectual property of the author-researchers and journals confidential.

Draft zero (D0), initial formation of research article. Draft zero (D_0) included the basic information for other drafts of the research article. As it was discussed under RQ1, the initial conditions provided the foundation for the science research project. Genesis of the research project included three elements; the two new grants offered by university, the real life experiences of researchers, and their expertise. The research team benefitted from these three elements to commence the project and to shape segments of the article as well. Also each of these elements was the source for production of a certain part of the article.

Two new grants. Since the fund for the research project in science was provided by the two new grants offered by the university, where the science project was conducted, the research team was required to include the source of grants in the manuscript. Thus from the very initial stage, even before the article's title was discussed by the research team, the grants were part of the written text in draft zero (D_0).

It is not exaggerating if said that the very first element in draft zero (D_0) was the details of the grants. In publishing articles some journals locate the details of the supporting grants immediately after the title of the article. But the journal, in which the multi-authored article got published, asked the research team to include the details of the grants within the acknowledgment section, at the end of the paper before the references. Figure 4.13 shows a segment of the acknowledgment section of the published article in which the supporting research grants were mentioned.

ACKNOWLEDGEMENT

The authors gratefully acknowledge……

……..

This work was supported by the GG Research Grant (UU.C/111/1/GG/111)and the University of U. Research Grant (GG111/11GGG).

Figure 4.13. Acknowledgment of the research grants as part of the written text

Among the readers of the published article were the university grants sources. They expected the grants to be acknowledged by the authors in the published article. The authors' "recognition of audience expectation" (Grabe and Kaplan, 1996.p. 215) provides the reason for writing the source of grants in a form that they include the name of the funding source as well as several digits which were meaningful only for the authors and the audience from the supporting grants.

Although Draft Zero (D_0) did not have a physical manifestation, instead it was shaped in other drafts. The authors allocated a segment of the written text to the grants from draft four (D_4) onwards. For instance when the grants were mentioned for the first time in the acknowledgment section of draft four (D_4), they were part of the embodiment of Draft zero (D_0).

Through the lens of model of parameters involved in writing (Grabe and Kaplan, 1996, p.207), to writer(s) knowing their audience "is essential" for "creation of text and the generation of meaning". Being aware that people from funding resources would be among their audience, the authors included the source of grants and the environmental issues in the research article text.

Real-life experiences. It is essential to briefly review the experience that the principal investigator had in her real life before conducting the research project. In

one of her trips to a rural area in Malaysia, Dr Janie visited a village where she heard stories about the inhabitants who became sick or even died of eating fish from river or drinking the natural waters around the village. Besides, Dr Janie saw "dead fish in parts of the river and ponds" (she stated in an interview). She explained that the village was surrounded by factories which, she suspected, had possibly released poisonous Z_2 in the rivers. Dr Janie stated that the real life experience of that village "triggered the idea" of collecting the deadly chemical from the natural waters in rural areas by using chemical detectors.

Based on that real life experience the first area which came to Dr Janie's mind for conducting an environmental research project was to apply a method to detect Z_2 by using XY_2, a chemical detector. In the introduction section of the published research article there were almost ten lines mentioning the threats that Z_2 had for the environment and lives of people and livestock. Figure 4.14 shows parts of the article's introduction in which segments of draft zero (D_0) related to the real life experiences of the principal investigator were embodied as text.

> …[Z_2] is one of the most toxic heavy metals known to organisms and the environment as even a trace amount of [it] is potentially disastrous when ingested.
> … [Z_2] contaminates the food chain and the environment.
> …The Z_2 limits for wastewater discharge and drinking water established by the World Health Organization (WHO) and…are….

Figure 4.14 Real life experience embodied as the written text

Expertise. Another element which contributed to the genesis of the research project was the expertise of the researcher-authors of the multi-disciplinary multi-authored science research article. Expertise can be defined in many ways. The research article text by itself was a product of an expert team. Although the expertise

alone could not appear as part of the written text, it was reflected throughout the entire research article. Obviously, the experimental, the analysis of findings, writing of the text and all other contributions were components of expertise that the researchers retained. An example of the expertise is evident in the division of labor when it comes to different tasks. The processes through which researchers conducted the laboratory work, the literature review, analysis, and as such they all reflect the expertise of the authors.

Regarding the production of the written text by experts, Bereiter and Scardamalia (1987, in Grabe and Kaplan 1996, p. 117) assert that "expert writers appear to go through a different sort of writing process, which allows these writers to transform information through an additional set of strategic processes". The authors' expertise is part of the answer to the question of "who" writes the text in the parameters involved in writing (Grabe and Kaplan, 1996, p.215).

Every text looks like "first draft" but it is never the first experience, especially in academic writing. Where necessary, in the published article, the authors used others' studies as well as their own previously published articles and cited them either to support their findings or question others' ideas. For instance Prof Tony (the senior researcher of the team) stated when they referred to another study they took "a short cut" to explain the matter, as the cited paper was "well-known in [their] field". Figure 4.15 is an example of how the authors' expertise and past experiences can enhance the quality of scientific text by linking the new findings to the existing knowledge.

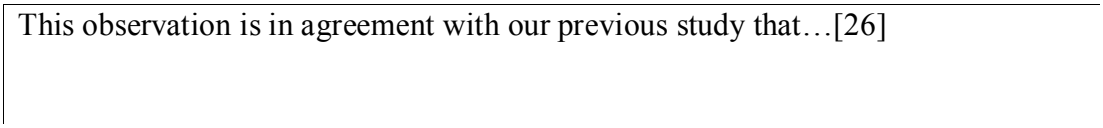

Figure 4.15. Authors' expertise appear in the research article text

This is an example of self-citation in which the authors of the research article used their previously published article to support their findings. Besides, depending on the specific expert contribution of the authors, different drafts of the article reflected the researchers' expertise, each discussed under the relevant draft.

Draft zero (D_0) also comprised other segments of the research article tentatively as they were all discussed by the co-authors. The discussions included the topic, title, initial list of authors, target journals, area of literature and the reference list, and the other subsequent processes of the research project. As researchers discussed the topic in the initial stages of research project, the tentative title of the research article was set in Draft Zero. The researchers who were invited to join the research team comprised the tentative list of co-authors. The principal author, Dr Janie, had targeted several journals for submission of their final draft for publication, thus the information about the journal was also part of the written text which took its initial shape in Draft Zero (D_0). Besides, as Dr Janie had already conducted the preliminary literature review, she had the literature section and the reference list at hand. The reference displayed the related studies used in the article.

Draft one (D1), hands on synthesis of XY2 particles. When the research project (or the complex system of writing and publishing multidisciplinary multi-authored research article) entered a new state researchers started the laboratory work for synthesizing XY_2 particles. Draft one (D_1) comprised multimodal texts including information about the materials, laboratory equipment, experiments, and the synthesized XY_2 samples.

In order to conduct the experiments, researchers first needed to have access to several necessary materials in the laboratory. Dr. Nick was in charge of supplying the

materials. He purchased the materials from different suppliers according to his experience in providing materials for previous studies. Figure 4.16 shows the section of the published article in which the information about the utilized material and their suppliers were given.

2.1 Materials

[X] chloride pentahydrate ($Xcl_4.5H_2O$, 98%) and ammoniac solution (NH_3, 25%) were purchased from [A&B] Chemicals. Hydrochloric acid (hcl,37%) and sodium chloride (NaCl, 99.5%) were purchased from [Merkem]. Sodium hydroxide,….were purchased from[Scichem], respectively. Distilled water was used throughout the [XY_2] sample preparation.

Figure 4.16. The materials used in laboratory are given in published research article

In the "materials" section of the research article the details about the material included the name of the chemical, its percentage, and the source from which the material was purchased. An interesting finding from this section is that the details for distilled water were not given by the authors. Later, I asked Dr. Janie about the reason, she explained that "…distilled water is something which can always be found in our libraries. It is provided by university and … [distilled water has] no certain effect on the experiments. We [only] use it for cleaning purposes", (from an interview with Dr Janie: Amid-D1).

This finding also shed light on the "careful consideration of the audience" (Grabe and Kaplan, 1996, p. 264) in production of the text. The authors of this scientific text assumed that their audience, by default, had the knowledge about the

details of distilled water used in the experiments; hence they did not provide more details in the text regarding the use of distilled water.

Regarding complexity theory, the terms referring to the laboratory equipment were elements of the complex system as they were parts of the system trajectory and states. The laboratory equipment used for the synthesis of XY_2 particles were mentioned in the text wherever needed. Figure 4.17 indicates the use of technical terms in the drafts of the research article by the multiple authors; the terms which revealed the direction (trajectory) of the system and its holistic behavior.

…on a scanning electron microscope…

…placed in an autoclave.

…using a centrifuge…

A chemical precipitator…

…using an X-ray diffractometer.

Figure 4.17. Equipment used in synthesis of XY_2 particles

Within the text, the researcher-authors did not declare all of the equipment used in laboratories due to their assumption towards the audience/readers of the research article. As Prof Tony stated, "the readers" of science research articles are "expected [by writers] to know some basics] about the researching process.

Another textual aspect was the genre of the written text. The authors who were aware of the accepted genre, as a component of the writing process, took advantage of technical terms, patterns, and equations to communicate with the readers of their text, a science research article. The multiple authors explained the synthesis process of XY_2

particles elaborately in the research article. An interesting example was the authors' use of several different terms for a single concept, the production of XY_2 particles. The authors used those terms interchangeably throughout the text. Figure 4.18 shows three of the terms frequently used by the multiple authors in the research article text which referred to the production of XY_2 particles.

> …particles were fabricated using ...
>
> …the prepared XY_2 particles…
>
> …have been used to synthesize smooth-surface XY_2 samples.

Figure 4.18. Using various terms for one concept by multiple authors

The use of various terms in reporting the synthesis of XY_2 particles was due to the authors' genre-awareness of the science research article. Prof Tony, the senior researcher in the team mentioned that "…in most of our papers…it is the trend to use these terms [(fabricate, prepare, synthesize)] in the manuscript…because our readers already know the science language [(genre)]".Also the principal author, Dr Janie asserted that "these [terms] are accepted by scientists [in our discipline] and you can see them in most papers". The authors' assertion of using certain terminology for production of text highlights the crucial "awareness of the readers' needs"(Cheng, 2007) in writing science research articles.

The authors' use of text, tables, figures, and images highlighted the interesting multimodality of the science research article. As Gallagher (2014) asserts, "multimodal texts stage encounters between and among composers and readers/viewers through the meaningful juxtaposition and combination of multiple modes" including "words, images, video, movement, and sound". The research article

text was enriched with different modes and the researcher-authors made full use of this aspect. One of the modes of the produced text was the graphs and figures in different drafts of the article. For instance in draft one (D_1) the first produced figure was showing the X-ray patterns of the prepared XY_2 samples and the bulk XY_2. Figure 4.19 shows the X-ray patterns of the synthesized XY_2 particles (A1, A2, B1, and B2) and bulk as a mode of meaningful text.

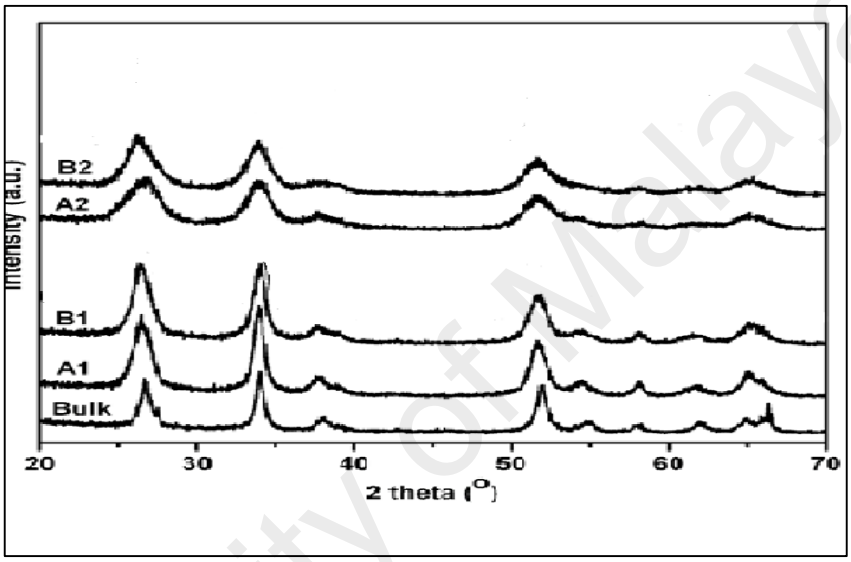

Figure 4.19. X-ray patterns of XY_2 particles and bulk in multimodal text

Tables were also used by the authors in the article in order to present the numeric form of data. Another mode of text produced in draft one (D_1) was in the shape of a table. Figure 4.20 provides the table for parameters of synthesis and the size of prepared XY_2 particles (A1, B1, A2, and B2).

Sample	XY_2	Solution 1	Solution2	Time of synthesis(h)	Size of particle (nm)
A1	15 ml, 0.7 M	1.0	6 ml, 0.100 M	4	24.6
B1	15 ml, 0.7 M	1.0	6 ml, 0.100 M	2	11.9
A2	15 ml, 0.5 M	0.5	6 ml, 0.100 M	4	6.5
B2	15 ml, 0.5 M	0.5	6 ml, 0.100 M	2	19.6

Figure 4.20. Details for synthesis of XY_2 particles in form of a table

Draft two (D2), characterization of XY2 particles. Draft two of the research article reflected the results from characterization of bulk XY_2 powder prepared in two different methods. Researcher-authors provided microscopic images of XY_2 particles that they had synthesized in two different methods. By displaying the two different images, the authors discussed how the conventional method (non-hydrothermal) was not suitable for preparing small and smooth-surfaced XY_2 particles. Figure 4.21 shows the images of the XY_2 sample prepared by the conventional method (left) and the samples synthesized by the new method (right).

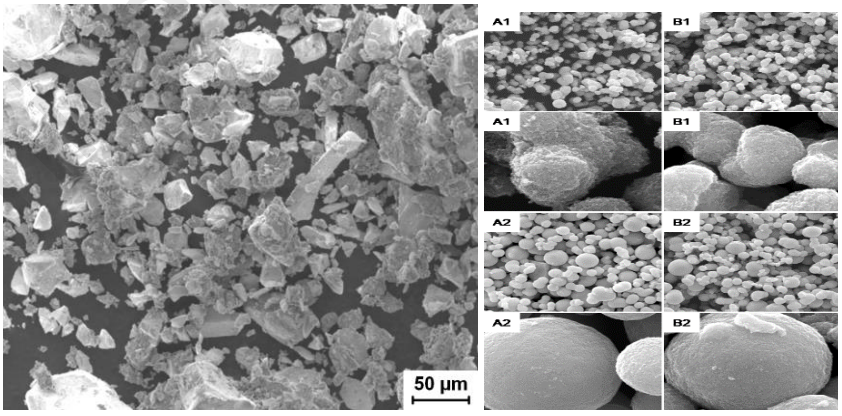

Figure 4.21. XY_2 particles prepared in two methods in characterization process

The newly synthesized XY_2 samples in Figure 4.20 (right) were named separately (A1, A2, B1, and B2) by the authors in order to discuss their characteristics one by one. Each sample has a pair of images. As Dr. Janie explained "this is the trend" and they "…needed to provide [the image of] each sample in two dimensions to give a better view of the samples" to the readers of the article.

In the multimodal text of the research article the authors' interpretation of images, in form of written text, served their audience in better understanding of the characterization process. The authors described the characteristics of XY_2 particles, giving scientific reasons for selecting only one type of XY_2 for the next step of their research process. To them "the smaller [XY_2] particles which also had smoother surfaces" were the most suitable samples for the next experiment, voltammetry.

Another component of draft two (D_2) as a multimodal text was the "schematic drawings" of XY_2 particles. The drawings illustrated the formation process of round-shaped smooth-surfaced XY_2 particles. Figure 4.22 is an example of the authors' attempt to explain the formation of XY_2 particles by showing the position of electrons.

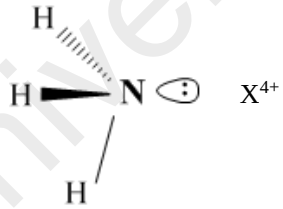

Figure 4.22. Use of symbols in showing the position of electrons in XY_2 particles

In the above figure the authors tried to show the position of X^{4+} towards a molecule of NH_3, one of the solutions used in the experiments. Later, in draft four (D_4), the authors connected six of the above pattern to create a circular shape of the XY_2 particles (see the new pattern in Figure 4.26), a suitable shape for testing XY_2 in another experiment called Voltammetry.

Draft three (D3), voltammetry of XY2 particles. The ultimate goal of the research project in science was to reach an XY_2 particle which could detect toxin Z_2 in in aqueous condition (e.g. natural waters). By characterization of XY_2 particles, the physical-chemistry researchers of the team reached a certain type of XY_2 which had the potential for detecting Z_2 in water. Afterwards, they sent the selected XY_2 sample to the engineers of the team for voltammetry, the next set of experiments which could measure the detection capacity of XY_2 samples.

In this scenario, the physical-chemistry researchers and the engineers were two groups of the agents of the complex system of writing and publishing a science research article. "In complexity theory, system elements are sometimes called "agents"...to refer to individual humans" (Larsen-Freeman & Cameron, 2008, p. 27). Although each agent played its own role separately, the influence of their work was reflected in the holistic behavior of the system.

The results of voltammetry measurement conducted by the engineers of the research team were the generated Voltammograms, by a computer connected to the Voltammetry equipment. Even though each graph was produced separately, the authors combined the three voltammograms in order to let their readers compare and contrast the results from Voltammetry. To Prof Zarimah (head of the engineers) "it is the trend" to bring all three graphs together in a science article "otherwise" it is considered "unusual" in "on-line publication[s]". This is due to the fact that "much academic discourse that takes place in the written mode is now mediated by electronic networks…that permits the inclusion of graphics and hyperlinks as well" (Duff, 2010). Figure 4.23 displays the three produced voltammograms by engineers of the team.

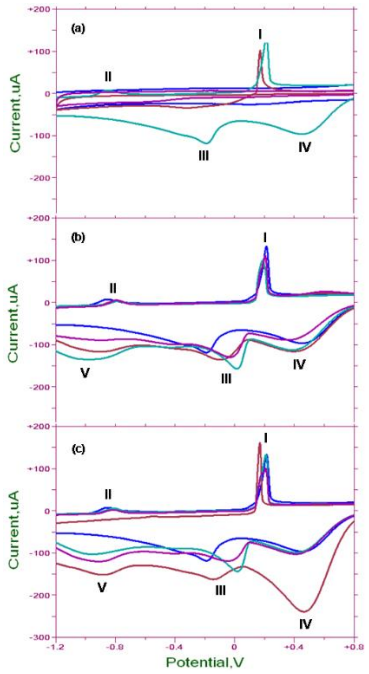

Figure 4.23. Color-coded voltammograms of XY_2 particles and bulk

An interesting finding from production of the text was that the authors benefitted from color-coding the voltammograms by using colors in interpretation of the curves and lines related to each XY_2 particle and bulk. In the complex system of writing and publishing a research article in science, colors are viewed as sub-components of the text, as a main component. This also highlighted the authors' audience-awareness, as the article was going to be submitted to an on-line journal where the intended-audience (Gastel & Day, 2016) could see the graphs and images in color, before they might even want to print them in gray style (i.e. black and withe). In the present study the multiple authors (i.e. *who*) were aware that their article would be published for an on-line audience (i.e. *to whom*), therefore they used colors (i.e. *how*) for interpretation of voltammograms in the written text (i.e. *what*). Figure 4. 24 illustrates Grabe & Kaplan's (1996, p.215) model of parameters involved in writing

which explains the relation of the text with its author(s) and receptor(s). This relation revealed the authors' audience-awareness in using color-coded voltammograms.

(*how*)

Multiple Authors ⟷ TEXT ⟷ RECEPTOR

(*who*) (Text construction: color-coded graphs) **(*to whom*)**

(*what*)

Figure 4.24. Grabe and Kaplan's parameters involved in writing (1996, p.215)

After the voltammograms showed that only one type of XY_2 particle (sample A2) had the highest potential for detecting Z_2 in water, the researcher-authors repeated the voltammetry for A2 particles. Figure 4.25 displays multiple voltammetry of XY_2 particle (type A2) conducted by the engineers of the team.

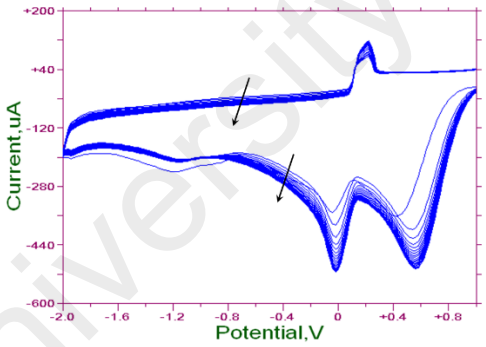

Figure 4.25. Multiple voltammetry of XY_2 type A2 confirms its detecting capacity

In the article the authors asserted that multiple voltammetry could "significantly" confirm the stability of A2, as the most suitable type of XY_2 particle for detecting Z_2. Hence, it was inevitable to produce more graphs to support the findings.

For more confirmation of the detection capacity of XY_2, researchers repeated voltammetry of (A2) XY_2 particle in different concentrations of Z_2. Prof Zarimah, the head of engineers, explained that "some aspects differed by changing the concentration of [XY_2, type A2], but the detection capacity is still high". Figure 4.26 shows the voltammograms of type A2 of XY_2 particles in various concentrations of Z_2.

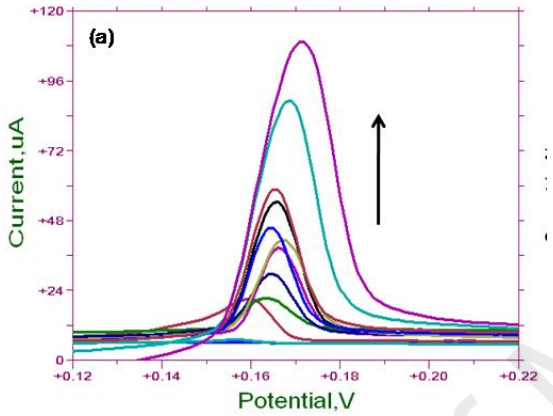

*Figure 4.26.*Various concentrations of Z_2 had no effect on detecting capacity of XY_2

Prof Zarimah, the head of engineers, stated that multiple voltammetry of the XY_2 particles, displayed in the above graph, "is meaningful to the readers even before reading the descriptions", (Interview with Prof Zarimah: Post-D4). This statement highlighted the importance of "genre-based literacy" (Cheng, 2007) of both writers and readers of science research articles. The writers used multimodal text to facilitate the comprehension of their findings. For instance the images of smooth-surface spherical XY_2 particles could prove the researcher-authors' claim on suitability of A2 type in detecting the toxin Z_2 in water.

Draft four (D4), first complete draft submitted to journal A. After Voltammetry confirmed the potential of the selected XY_2 for detecting Z_2 in water, the research team and most specifically the principal author Dr Janie started to assemble

all findings and the previous drafts in order to form the final draft for submission to Journal A.

In re-organizing and reviewing the text the authors wanted to improve the quality of the article as much as possible to increase the chance of publication. In assembling drafts and segments of the complete article, one change was quite bold. The principal author, Dr Janie, had a discussion with Prof Tony and Dr Nick for improvement of a drawing (shown in Figure 4.20 of the present thesis). The authors decided to add another schematic drawing to the text immediately after the previous drawing, in order to improve the intelligibility of the formation process of XY_2 particles for the readers of the research article. Prof Tony, the senior researcher of the team, believed that the new drawing comprehensively "increases the technical validity of the paper". Figure 4.27 is the new drawing produced by Prof Tony for draft four (D_4) and it was located in the article immediately after the previous drawing.

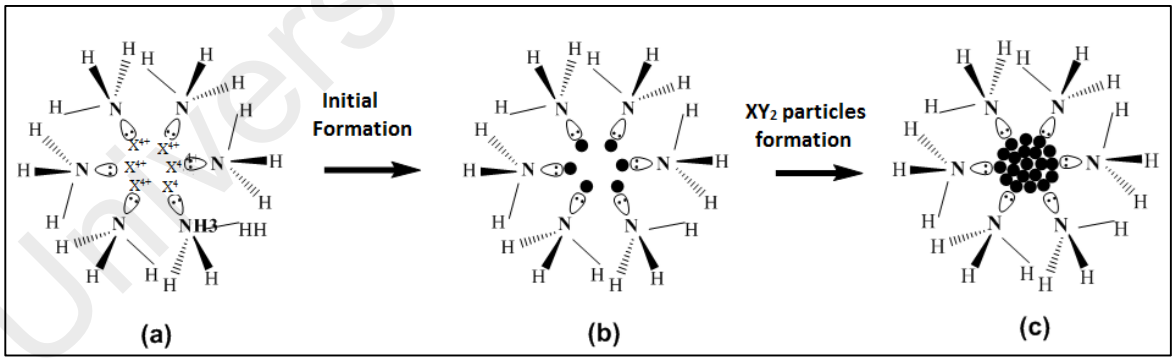

Figure 4.27. New drawing of symbolic XY_2 crystal formation

Another part of the article which was extremely influenced by various components of the complex system was the list of authors. In the following the reflection of influences on the list of authors is explained.

List of authors. Since the early stages of the research project there were eight researchers as the authors of the research article. But due to an authorship issue which occurred before submission of draft four (D_4) to Journal A, the number of authors in the list of co-authors was reduced. In fact, there were several authorship issues occurred during the production of drafts zero to four (D_0- D_4). Table 4.5 shows the list of authors for each draft of the research article.

Table 4.5

Researcher-Authors of Drafts of the Research Article

Drafts	**Researchers/Authors Involved**	**Number of Authors**
Draft 0 (**D_0**)	Dr. Janie- Dr. Nick- Prof. Tony	3
Draft 1 (**D_1**)	Dr. Janie- Dr. Nick- Prof. Tony- Dr. Yang- Prof Zarimah- Dr. Harry- Dr. Lee- Mr. Ken	8
Draft 2 (**D_2**)	Prof Zarimah- Dr. Janie- Dr. Harry- Dr. Lee- Dr. Nick- Prof. Tony- Dr. Yang- Mr. Ken	8
Draft 3 (**D_3**)	Dr. Janie- Prof Zarimah- Dr. Harry- Dr. Lee- Dr. Nick- Prof. Tony- Dr. Yang- Mr. Ken	8
Draft 4 (**D_4**)	Dr. Janie- Prof Zarimah- Dr. Harry- Dr. Lee- Prof. Tony- Dr. Yang	6

As it is displayed in Table 4.5, in draft zero (D_0) which was the initial formation of the research team, there were only three researchers in the team: Dr. Janie, Dr Nick, and her former supervisor Prof Tony. Later these three researchers had discussions

about the processes of the research project and the result was joining of the other researchers to the team.

In addition to Dr Janie, Dr Nick, and Prof Tony the names of three engineers were added to the list of authors of draft one (D_1) along with one more researcher from chemistry and Dr Janie's doctoral student. This made up the number of researchers to eight.

Draft two (D_2) had the name of Prof Zarimah, head of the engineers of the team, as the first author, followed by Dr Janie as the principal researcher, the other two engineers, and then the physical-chemistry researchers. This authors' order was formed due to an agreement between Dr Janie and Prof Zarimah to put Prof Zarimah's name as the first author. But this authors' order did not last much because Dr Janie's head of department did not agree on the authors' order which appeared on the top of the article. Therefore, in draft three (D_3) Dr Janie's name appeared as the first author since she was the head of project and also the principal investigator of the research project.

Yet the most important authorship issue occurred before submission of draft four (D_4) to the first target journal of the research team, named as "Journal A". The finalized draft of the article was sent to the head of department for approval but the person raised an issue which was "not fair" or "ethical" to Dr Janie and the rest of team members. The head of department asked for the withdrawal of Dr Nick's name from the list of authors before submission because he happened to be Dr Janie's "husband" and to the head of department "he seemed to have no significant contribution to the project" (from interviews with Dr Janie, the principal investigator of the research

project in science). This affected the final list of authors in the way that the name of Dr Nick did not appear on the top of article as one of the multiple authors.

Another researcher who had significant contribution to the laboratory work but his name did not appear on any of the drafts was Mr. Ken. He was Dr Janie's doctoral student and joined the research team as part of his doctoral studies and to gain experience as well. Dr Janie and Mr. Ken had agreed, from the initial stages of the research project, that Mr. Ken's name would not be appear in the article as one of the multiple authors. One of the interesting findings related to the authorship issue is that Mr. Ken's name did not appear even in the acknowledgment section of the published article.

The authorship issues discussed so far made changes to the authors' list as it was shown in table 4.5. It is worth noting that during the submission and re-submissions of drafts four to eight (D_4-D_8) the authors' list and their name order remained unchanged. After some time the research team received Journal A's decision about the submitted article.

Draft four (D4) rejected. Journal A, the first target journal of the research team, rejected the article due to several issues. Dr Janie, who was the principal and corresponding author of the article, received an email containing Journal A's comments and feedback on the paper (full content of the feedback and comments on the submitted article to Journal A is provided in Appendix F). Figure 4.28 displays parts of the comments which were important in production of forthcoming drafts of the article.

C - Does abstract cover pertinent points?

YES_____ NO_*____

D - Is the experimental procedure correctly conducted and described?

YES____ NO_*____

E - Are discussion and conclusions based on sufficient data?

YES____ NO___*__

F - Can the text be abridged or amended, and/or part of the illustrations and tables be eliminated without altering the technical content:

YES__*___ NO_____

#The authors prepared just [X] samples including the ----- ------ samples and based on this they are making sweeping statements in the results.

#Results and discussion section should be completely rewritten as they are making invalid comparisons. For example, page 6, lines 66-66:Comparison of Figure1 and Figure2 is invalid as you have changed two variables i.e., you changed both [XX] and [LL] concentrations and hence can't talk about ---- -----. LLL concentration should be kept constant if you want to see the role of ------ -------.

… Because of all these issues this paper in its current form is not acceptable for publication.

Figure 4.28. Comments and feedback from Journal A after rejection of manuscript

Among the comments from Journal A were requirements for adding more samples to improve the paper, but the research team decided not to synthesize any more samples at this stage of the project. After discussing the rejection of draft four (D_4) and the feedbacks the research team decided to re-submit the article to their

second target journal, with minimal changes to the text. Therefore, draft five (D_5) was produced for submission to Journal B.

Draft five (D5), re-submission of article to new journal (journal B). Since Journal B was a new target for re-submission of the article, the principal author made some changes to the text in order to adjust the text to Journal B's requirements. Two major changes to the text of the research article took place in the reference section of the article and in citation of studies throughout the text.

In a complex system, energy from outside or any imposed change results in change in behavior of the whole system. Here, the whole publishing process had to be on standby until Journal B's requirements were met. One of the changes to draft four (D_4) that the researcher-authors had to make before submission of the new draft (D_5) to Journal B was to the reference section. Referencing style is a drafting requirement imposed by journals; each journal has its own referencing style which might be different from other journals. Therefore, if the authors decide to submit the paper to a new journal the manuscript has to be amended accordingly. Table 4.6 shows an example of the difference in referencing style of Journal A and Journal B.

Table 4.6

Change in Referencing Style

Draft	Referencing style
Draft four (D_4), submitted to **Journal A**	(1) Krishna, M., Komarneni, S., (2009) Conventional- vs microwave-hydrothermal synthesis of tin oxide, SnO2 nanoparticles. *Ceram. Int.* 35, 3375–3379.
Draft five (D_5), submitted to **Journal B**	1. M. Krishna, S. Komarneni, *Ceram. Int.* 35 (2009) 3375.

Journal A, the first target journal of the research team, required the authors to place the studies, in the reference section, in the same order that they appeared in the article; but not in alphabetical order. Referencing each study started with a number between parentheses. After the number, author(s)' last name was followed by the initial letter of their first name; then the year of publication was given; and next the article's title was followed by the journal's information including italicized name of the journal, volume, and starting-ending pages.

After the article was rejected by Journal A the authors decided to re-submit the manuscript to another journal, called Journal B. Hence, the authors had to re-write the reference section based on Journal B's requirements. In Journal B's referencing style the numbers were not in parentheses; instead there was a dot after each number. Then the initial letter of the author(s)' first name was followed by their last name. Next, the journal's information including its italicized name, volume, year of publication, and the starting page of the article within the journal appeared. Also, the reference in Journal B contained less number of words, compared to Journal A.

There were several interesting findings in the differences between Journal A and Journal B referencing styles. The numbers were either between parentheses or only had one dot after them. Names and last names changed place in the two journals. And most interestingly, Journal B did not require the authors to add the study title in the reference section.

Another textual component that the researcher-authors had to change before re-submission of the article to a new journal, was the in-text citation style. Table 4.7 compares the citation of a study in draft four (D_4) and draft five (D_5).

Table 4.7

Citation Style, Different among Journals

Draft	In-text Citation Style
Draft four (D_4), submitted to **Journal A**	Z_2 is one of the most toxic metals found in natural waters[15].
Draft five (D_5), submitted to **Journal B**	Z_2 is one of the most toxic metals found in natural waters [15].

For Journal A, to cite a study within the text of the article the authors were required to use small numbers just above the line of text (e.g. "text[15]"). After the authors decided to re-submit the article to another journal, they had to follow the in-text citation style of the journal. For citing studies, Journal B required the authors to use brackets in the line of text with numbers between them (e.g. "text [15]"). This indicates that the readers of some texts can force the way a text is written. Since each journal has its own requirements, the authors had to follow the instructions of that specific journal for submission of papers.

Dr Janie, the principal author of the article, believed that the "rejection [could buy] time" for the research team and the "comments" could "enhance" the quality of the article for re-submission to another journal. Therefore she sent the article to all co-authors for improving the quality of the paper. Table 4.8 shows specific examples of how the multiple authors improved draft four (D_4) to produce a new draft (D_5).

Table 4.8

Text Enrichment by Multiple Authors

Draft	**Correctin & Author**	**Written Text (Improvement)**
Draft four (D_4), submitted to **Journal A**	Prof. Tony	XY_2 is a…
	Mr. Ken	…and stoichiometry-violating…
	Dr Janie	…the surface of C2 is rougher C1, as reflected in…
	Dr Yang	…XY_2 bulk (red curve)
	Dr Janie	Non-HT XY_2 (yellow line)
Draft five (D_5), submitted to **Journal B**	Prof. Tony	XY_2 could be a…
	Mr. Ken	…and stoichiometry-violating…
	Dr Janie	…the surface of C2 is rougher than C1, as it is reflected in…
	Dr Yang	…XY_2 bulk (purple curve)
	Dr Janie	XY_2 bulk (yellow line)

As shown in Table 4 .8 the researcher-authors reviewed the rejected draft four (D_4), each found some grammar errors and misspellings, resolved the problems, and returned the corrected draft to principal author. Dr Janie modified the text accordingly before submission of the article to Journal B.

Draft five (D5) accepted conditionally. After D_5 was submitted to Journal B for the first time, it was accepted by the journal subject to some changes both to the text and to the scientific content of the paper. Journal B required the researcher-authors to provide two more XY_2 samples to strengthen the authors' claim on the potential that XY_2 had in detecting Z_2 in water. So the researches had to repeat all the processes of synthesis, characterization, and voltammetry for the new XY_2 samples, in addition to improve the textual quality of the article.

Draft six (D6), article re-submission to journal B. For writing a new draft which could satisfy the requirements of Journal B, the researchers had to go back to laboratory again for synthesizing the new XY_2 samples and going through the processes of characterization and voltammetry. Besides, the multimodal text of the article went under change in different sections. To better understand the changes to the text, the components are explained in this section.

The researchers synthesized two new XY_2 samples after Journal B returned draft five (D_5) and requested for addition of at least two more samples to the previously synthesized XY_2 particles. The new samples were synthesized in absence of ammonia solution (NH_3). The newly synthesized XY_2 samples also went through characterization process for their shape and characteristics, and voltammetry process for testing the detection capacity. The two new samples were called C1 and C2. Figure 4. 29 shows the characteristics of the previous and new XY_2 samples.

Sample	XY_2	Solution 1	Solution2	Time of synthesis(h)	Size of particle (nm)
A1	15 ml, 0.7 M	1.0	6 ml, 0.100 M	4	24.6
B1	15 ml, 0.7 M	1.0	6 ml, 0.100 M	2	11.9
C1	15 ml, 0.7 M	1.0	-	4	41.4
A2	15 ml, 0.5 M	0.5	6 ml, 0.100 M	4	6.5
B2	15 ml, 0.5 M	0.5	6 ml, 0.100 M	2	19.6
C2	15 ml, 0.5 M	0.5	-	4	24.8

*Figure 4.29.*Two new samples, C1 & C2, added to the table (compare with figure 4.19)

Various types of XY_2 particles had different characteristics from each other in the sense that A1, B1, C1 types of XY_2 had higher density compared to A2, B2, and C2. This made their computer-generated images different from each other.

Throughout the research article text, each sample (A1, A2, B1, B2, C1, C2) was frequently discussed where the researcher-authors needed to refer to a specific type of XY_2. Although researchers synthesized each type separately, all twelve images of various XY_2 particles were presented in one graph within the article so that the readers of the article could compare and contrast the images. This juxtaposition of images only appeared in the submitted drafts of the article to the journals.

The addition of the two new samples made dramatic changes to the text. The changes included the addition of new graphs, addition of several studies to the literature and reference list, and changes in analysis of the graphs and diagrams. Figure 4.30 shows the computer-generated images for the two new samples that were added to the previously generated images of XY_2 particles in draft four (D_4).

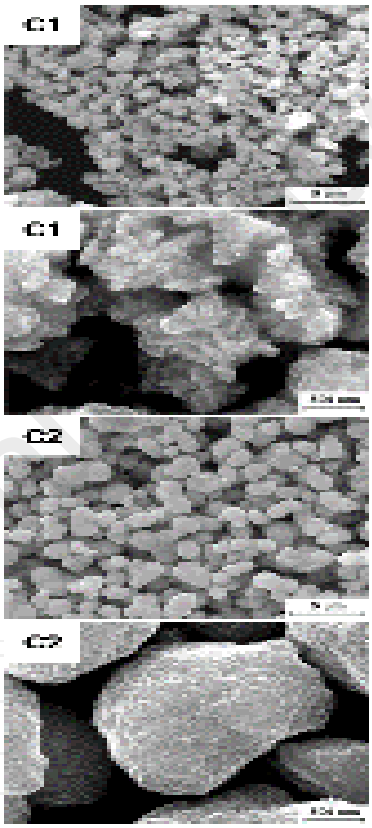

Figure 4.30. Images of the two new XY_2 samples

After synthesis of the two new XY_2 samples and generating their images, the forthcoming drafts of the article comprised both previous and new images coming together. Therefore, the drafts 6-8 of the research article (D_6, D_7, D_8) included more images compared to drafts 4and 5 (D_4 & D_5).

Another graph which differed from the previous ones was the X-ray patterns of all synthesized XY_2 particles including the two new ones (C1 and C2). Figure 4.31 displays the finalized X-ray patterns of all XY_2 particles presented in the submitted drafts of the research article to the journal.

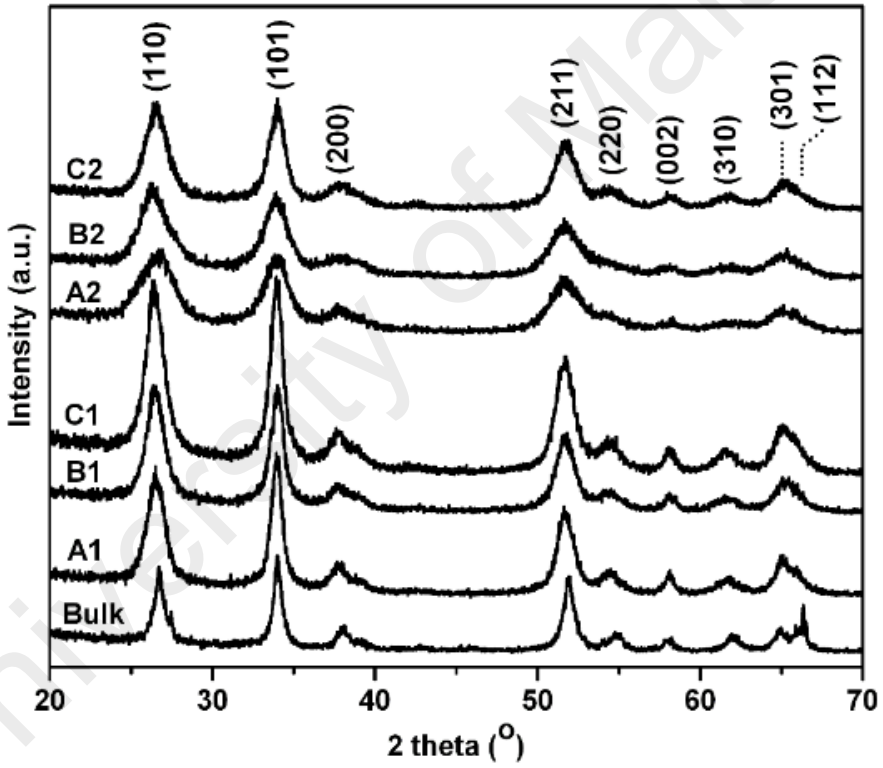

Figure4.31. Addition of the X-ray patterns for the two new samples (C1 and C2) (compare it with Figure 4.18)

Draft seven (D7), final re-submission of article to journal B. Due to several textual problems, Journal B did not fully accept draft six (D_6) and required the

researcher-authors to further improve the text. Therefore, Dr Janie asked the other co-authors to help in enhancing the text. This time the changes to the article were minimal and to the principal author, Dr Janie, the article only needed a "touch up", (interview with Dr Janie: Pre-D8). There were totally four changes made to the text of draft six (D_6). Table 4.9 shows parts of the changes made to draft six (D_6) in order for the authors to produce draft seven (D_7).

Table 4.9

Changes to Draft Six (D6) of the article

No	Drafts	Text and Changes
1	D_6	*Keywords:* Detecting potential; Heavy metals; Voltammogram
	D_7	**Keywords:** Detecting Potential, Heavy Metals, Voltammogram
2	D_6	26 studies were referenced. An in-text citation was missing in D_6 reference list.
	D_7	27 studies were referenced. A study was added to the list of references: 18. J.Lu, X. He, X. Zeng, Q.Wan, Z. Zhang, *Talanta* 59 (2003) 553.
3	D_6	24. D.H. Gray, S. Hu, E. Juang, Gin, D.L. *Adv. Mater.* 9 (1997) 731.
	D_7	24. D.H. Gray, S. Hu, E. Juang, D.L. Gin, *Adv. Mater.* 9 (1997) 731.
4	D_6	…and ammonia solution (NH_3, 25%)
	D_7	…and ammonia solution (NH_3, ~25%)

The first change to draft six (D_6), required by Journal B, was to the punctuation used in the keywords of the article. The term "keywords" was italicized in D_6 whereas it was required by Journal B to be bold and not italicized. If a keyword consisted of two parts, the second part had also to begin with a capital letter. Using "Detecting Potential" instead of "Detecting potential" is an example. The other change in writing the keyword section of the article was on the punctuation between two keywords. A comma (",") had to divide the keyword instead of a semicolon (";"). So, the former punctuations were replaced by the new ones in production of draft seven (D_7).

The second change to draft six (D_6) was related to a missing reference. The multiple-authors had cited a study in the text of research article but it did not appear on the reference list of draft six (D_6) manuscript. The authors included the study in the reference section of the article and number "18." was allocated to the new reference.

The third change to draft six (D_6) was due to a typographical error. In one of the references (number 24.) the first and last name of one author had changed place. Dr Janie explained "because references [were] not too many" they wrote the reference list "manually", therefore they did not use "automatic" referencing when they re-submitted the article to the new journal (Journal B). To Dr Janie, "typos [were] inevitable". An interesting aspect of this typo error in reference (number 24) was that every component was correctly written and located before and after this author's (last) name. Only because one author's name was not written in the required form, Journal B asked the researcher-authors to change it as one of the requirements for accepting the article for publication.

This finding highlights the "interdependent connections" (Geyer, 2004) and "interconnected" relations (Larsen-Freeman & Cameron, 2008, p. 232) between and among all components of the complex system of writing and publishing a multi-authored research article. The interconnectedness of all components of the complex system finally changes the behavior of entire system. In this scenario the system behavior is reflected in production of a new draft (D_7) including the required alterations in the text.

The fourth change to draft six (D_6) was adding a missing "tilde" (~) before the percentage of a solution in the *Material* section of the research article. According to the comments received from Journal B "a tilde superscript must be added before 25%" in order to "prevent" an "incorrect claim" in purity of ammonia solution. The authors had to show that the percentage of that material was "approximate", otherwise they had committed a "wrong affirmation", as Dr Janie put it this way. This interesting finding sheds light on the *how* parameter involved in the writing process (Grabe & Kaplan, 1997, p.213) of a research article in science. The way the percentage was written, without giving a tilde (~), could be considered a claim by the researcher-authors that the ammonia solution was accurately 25%. Adding a single tilde before the percentage had a huge contribution to the meaning raised by the authors. Thus, how a material is introduced by authors in a science research article can make changes to the whole text and therefore to the generation of meanings for the audience (Grabe & Kaplan, 1997, p.207).

Draft eight (D8), published research article. Draft eight (D_8) was the research article finally published in Journal B and it differed from draft seven (D_7) in some aspects. Draft seven (D_7) which was the last draft of the research article submitted to Journal B did not contain the complete information about the journal. It

is mostly part of the journal's input to the text of article to add information about the publication time and the journal's issue, volume, and also pages of the journal where the article can be found by readers. Therefore, at the time of submitting draft seven (D_7) to Journal B the research team was not assured about the journal's issue and pagination. Figure 4.32 shows the heading of the published research article in Journal B (D_8).

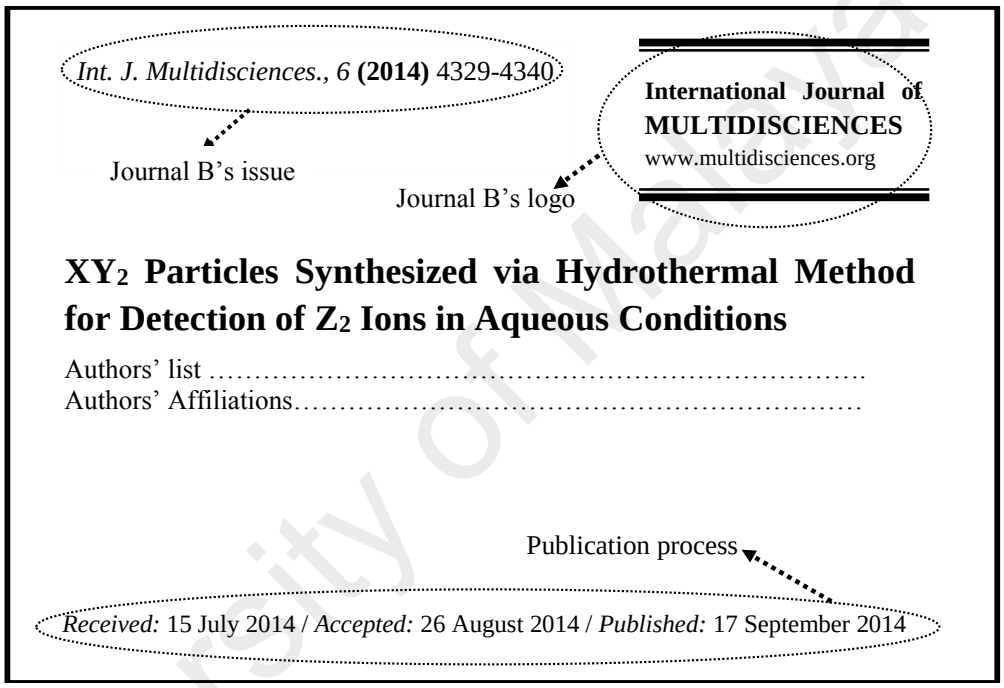

*Figure 4.32.*Article's heading for the published article in Journal B
*(For protection of the research team's intellectual property the journal's title and other information are altered)

For draft seven (D_7) the article's heading included the title, list of multiple authors, and their affiliations which was submitted to Journal B in a separate file from the main text of the article. But, in the published draft of the article (D_8) further information were added to the heading by Journal B. As it was indicated in Figure 4.31 the information in the article's heading were about Journal B's issue in which the article was published, the journal's logo, and also brief information about the publication process.

The trend in research articles in social sciences and humanities is usually to have a comprehensive section on methodology for data collection. But for this multi-authored science research article the format of the sections was different. For instance, in methodology section of the article the whole data collection process was only briefly explained. In the succeeding sections of the article, after methodology, the important parts of data collection (e.g. experimental) were discussed and connected to the analysis and results. The principal author, Dr Janie, stated "in scientific experiments most of the times [researchers] follow certain standards which is accepted [and understood by all scientists]". Hence, in the methodology section of the article researcher-authors only mentioned "what" type of method was used and in the analysis section they explained "how" the data was collected and the experiments were conducted. Table 4.10 shows headings within the text of the published research article.

Table 4.10

Headings of the Published Research Article

No.	Sections of the Published Article	Content of each Section
1	Heading	Title, List of Authors and Affiliations, Abstract, Keywords, Publication-Journal's information
2	Introduction	Literature, Methodology, Findings
3	Experimental	Materials, Synthesis Process, Characterization, Voltammetry
4	Results and Discussion	Figures, Tables, Images, Drawings, Interpretations, Descriptions,

Table 4.10 continued

5	Conclusion	Abstract-like Ending, Suggestion for Further Research
6	Acknowledgement	Other Contributors to the Article, Grants Supporting the Project
7	References	Studies Cited in the Article

Despite Dr Janie mentioned that she usually followed the standard framework of IMRD (Swales, 1990) for writing different sections of their research articles, the published research article differed from what she claimed earlier. In the published research article the section for methodology/method was replaced with "Experimental", which was indeed a form of methodology for conducting science research. The sequence of the subjects appeared in the published article was different from the order of the subjects in different drafts of the article.

Summary of research question three (RQ3). Research question three (RQ3) of the present study analyzed the drafts of research article produced in several states of the complex system of writing and publishing the multidisciplinary multi-authored research article. By providing segments of drafts of the article it was tried to show the impact of interrelated components of the complex system on the produced text, which was a component of system by itself. The nine produced drafts contained various segments of the finally published research article:

Draft zero (D0) provided the initial conditions for the complex system to commence. In fact the initial conceptualization of the research article was based on the components of draft zero. Although draft zero did not have much physical

manifestation, acknowledgement, self-citation of previous works, and environmental warning were among few reflections of initial conceptualization on the text.

Draft one (D1) reflected the work of physical chemistry researchers, Dr Janie, Dr Nick, Prof Tony, Dr Yang, and Mr. Ken, who synthesized the XY_2 particles and bulk. Parts of the text produced for draft one were the introduction of materials and equipment, X-ray patterns of XY_2 particles, and tables indicating the parameters of synthesis.

Draft two (D2) comprised images from characterization of four XY_2 samples and the interpretations of images; also x-ray images and their interpretations were produced fro draft two.

Draft three (D3) consisted of voltammograms and their interpretations produced by the engineers of the research team, especially by Prof Zarimah. Parts of the text were revised by the principal author, Dr Janie.

Draft four (D4) was the accumulation of all previous drafts which shaped the first complete draft of the research article. This first complete draft was sent to Journal A for publication, but got rejected.

Draft five (D5) was the beginning of re-submission of complete draft of the article to a new journal, Journal B. Draft five comprised almost all the content of draft four except that the authors had to amend the text in order to meet the requirements of the new journal. Because Journal B returned draft five to the research team and asked them to synthesize more samples and make some changes to the text.

Draft six (D6) was the second re-submission of the research article to Journal B. This draft comprised new content from synthesis of two new XY_2 samples

including more images, tables, drawings, and the improved interpretations for them. But Journal B returned draft six to the research team for further revisions.

Draft seven (D7) was the third and final re-submission of research article to Journal B. The research team followed the instructions of Journal B and enhanced the quality of the whole text. Draft seven was fully accepted for publication in Journal B.

Draft eight (D8) was the published research article in Journal B's website. Some new elements were added to the text by Journal B including the information about the journal issue, pagination, and Journal B's logo. When draft eight (D8) was produced and published, the complex system of writing and publishing a multidisciplinary multi-authored research article reached a fixed point attractor and the multiple authors could not make any more changes to the text. Table 4.11 summarizes the processes through which each draft of the article was produced and the content of each draft.

Table4.11

Contents of Drafts of the Research Article

Draft	**Produced Through**	**Content**
D0	Initial Conceptualization	Authors, topic, title, journal, grants, real-life experience, expertise
D1	Synthesis of XY2 and bulk	materials, technical terms & equipment, X-ray, particles parameters
D2	Characterization of XY2	8 microscopic images of 4 samples; schematic drawings
D3	Voltammetry of XY2	color-coded graphs; multiple graphs (all in one); various concentrations
D4	First complete draft of RA	New schematic drawing; finalized list of authors (6);

Table 4.11 continued

D5	Second complete draft of RA	D4-rejection;new referencing-citation style; authors' text improvement
D6	Third complete draft of RA	2 new XY2 samples, images, X-ray patterns, graphs
D7	Fourth complete draft of RA	Final revision of text
D8	Published research article	Articles heading: journal's issue, logo, publication process, template

Next chapter provides the conclusion on the findings of the present study. Theoretical and practical implications and contributions of this study are also discussed. Also, there were some methodological issues which restricted this study to some extent. Those issues are also argued in chapter five, next chapter.

CHAPTER 5 DISCUSSION, IMPLICATION, AND CONCLUSION

Introduction

In this study I set out to explore the processes of writing and publishing a multidisciplinary multi-authored science research article and explain the entire research process through the lenses of complexity theory (Larsen-Freeman and Cameron, 2008) and model of parameters involved in writing (Grabe and Kaplan, 1997). This chapter presents a summary of the findings under writing, publishing, and text of the research article. The chapter also gives a discussion of results, implications, and recommendations for further research related to the topic of writing and/or publishing processes of multidisciplinary multi-authored research articles. This thesis was motivated by three research questions:

RQ1. How is the process of writing multidisciplinary multi-authored research article carried out by ESL authors?

RQ2. How is the process of publishing multidisciplinary multi-authored research article carried out by ESL authors?

RQ3. How is the text shaped in the process of writing and publishing multidisciplinary multi-authored research article?

In answering the questions, the research revealed that not all writing tasks follow the five conventional steps of pre-writing, drafting, revising, editing, and publishing (Nordin, 2017). These steps of writing process are "rather more accurately conceptualized as overlapping parts of a complex whole or parts of a recursive process that are repeated multiple times throughout the writing process" (Flower and Hayes, 1981). The following sections present more discussions emerging from the findings

of the present study in order to reach a conclusion on the implications and contributions of this study to the field.

Writing Process of Multidisciplinary Multi-Authored Research Article

This study is unique in using complexity theory for analysis of findings. Looking at the authentic task of writing a multidisciplinary multi-authored research article in science through the lens of complexity theory is significant in two ways. First is the focus of the present study which is on the process of shaping and re-shaping of drafts of research article. Secondly, using complexity theory for looking at a *writing process* is noteworthy. Hyland (2003) states that "process approaches have had a major impact on the ways writing is both understood and taught, transforming narrowly-conceived product models and raising awareness of how complex writing actually is".

For the ESL authors of the research article, which went under scrutiny in this study, drafting of the research article had its own complexities and rewards. In an interview with the principal author of the research article, Dr Janie, when I asked about difficulties she faced during writing of the article (as an ESL writer) she started, by retrospectively talking about her past experiences "…in the first 10-15 articles that I published I learned a lot from my co-authors and, frankly speaking, I am still learning new things in every [new] project…". Then Dr Janie continued:

> …about difficulties… I should say that I'm almost established in the field and I've passed that stage, at least I feel so, and… of course we can never compete with native scientists from the UK or the US in the writing part. But the scientific experiments and explorations are not [very much related to] our language proficiency. We should only be able to report our findings clearly so that other scientists

> understand our work. … For us is also the same. We learn a lot from others' works and experiments.
> (Interview with Dr Janie: Post-D8)

From the above interview several facts, seen by an ESL expert writer in the field of science, were revealed. Learning from others in collaborative research work and producing multidisciplinary multi-authored articles is a key to more achievements for these ESL authors. Being established in the field gives writer sufficient experience and confidence to write and to submit their articles for publication. ESL writers are aware of the differences between the writing of native English writers and of their own. But, in some disciplines such as chemistry and physics, for journals scientific facts are more important than the perfectly and correctly written text of the article.

Publishing Process of Multidisciplinary Multi-Authored Research Article

Publishing process was another sub-system of the complex system of writing and publishing a multidisciplinary multi-authored research article in science. It was nested within the bigger system along with other sub-systems such as writing process and several other components.

Although in the analysis of the findings publishing process (RQ2) came after writing process (RQ1) and it seemed to be started right after the draft four (D4) of the article was submitted to Journal A, publishing process was commenced since the very early stages of the research project in science.

Publishing process started when the research team discussed and decided on the target journals for submission of their final draft. Among all co-authors, the principal author, Dr Janie was the one who had the responsibility and final say in the selection of journal. Her expertise in science research and publication helped her in journal selection which was almost the first stage in the publishing process. Therefore,

the publishing process as a sub-system of the complex system was already active, influencing and being influenced by other sub-systems and components.

Research Article Text as Product-Component of Complex System

The text was a product-component of the system of writing and publishing multidisciplinary multi-authored research article. Components of this complex system were all interrelated in the way that each and every component contributed to re-producing and re-shaping of drafts of the research article. This highlighted the dynamic nature of the complex systems mentioned by Larsen-Freeman and Cameron (2008).

In the model of parameters involved in writing by Grabe and Kaplan (1997) the *when and where* parameters (p.215) imposed the selection of text for submission to the journals. Parts of the text in different drafts were not reflected in the published RA because they were written only for the sake of co-authors to be informed of different phases of research process, project progress, and results from experimental. In the submitted RA for publication and also in the published RA, only the important (necessary) results were reflected for the audience. *When* the text was produced and *where* it was seen by readers determined the content. In this study, text is seen as a component influencing and being influenced by other components.

Implications

This study found a way to work with a complex system to produce "more accurate and more useful descriptions and explanations" (Larsen-Freeman & Cameron, 2008, p.4) for process of writing and publishing research articles.

The major implications of this study are introduced here under two categories, pedagogical-practical implications and theoretical implications.

Pedagogical-practical implications. This study was an effort to capture the complexity of a real-life writing task, i.e. the writing and publishing of a multidisciplinary multi-authored research article in science. The writing of the research article in English by its ESL authors made it very relevant to the field of TESL (Teaching of English as Second Language) because of its implications for publishing in international English journals.

With a lot of pressure on researchers to publish their findings nowadays, they need to be more familiar with the writing process. Many of these researchers are also willing to co-author multi-authored papers. This study deals with training, teaching, and learning to write research articles for publication. The findings of the present research has implications for writing centers within universities and writer-training programs. The most effective writing instruction is probably the one which helps students know how their writing is influenced by or connected with other components or the context around them within which they do the task of writing.

The real-life experiences of a team of researcher-authors which was reflected by the present study sheds light on the patterns and lessons that novice researchers can learn for publication of their new findings. Awareness-making on the writing of research papers "is also an important way to introduce students to synthesizing and information reporting, basic activities in all academic [writing] classes" (Grabe & Kaplan, 1997, p.367).

The present study has benefits for research centers in universities, lecturers, and students who are encouraged to do research and publish their findings, especially in journals. The findings of this study has also rich implications to help universities

conduct workshops for staff improvement and encouragement of collaborative research based on the findings of the present study.

For conducting workshops, there are some important items in the following which I strongly recommend to be included in the content, based on the findings of the present study:

1) Researching process
2) Writing and publishing processes
3) Collaborative research
4) Multidisciplinary research
5) Authoring and multi-authoring
6) Researcher-author

There are certain lessons and patterns that novice researchers can learn from the findings of this study. In the content of the suggested workshop, some of these lessons and patterns are included.

Researching process: the first thing academic staff and university students need to know about researching process is that research is a process of investigation, even though systematic, replete with predictable and unpredictable sub-processes. Also researchers are expected to reach new findings and/or conclusions.

Writing and publishing processes: these may seem two separate processes in nature, but writing a research article is not a passive reporting of investigations. Journal selection is a good example for proving the interconnectivity of writing and publishing processes, rather than considering them as two separate entities. From the very initial stages of the researching process, researchers target their journal(s) for submission of their manuscript and therefore lead their research in a way that they

could report the findings which fit into the scope of those specific journals. This concept must be taught in the workshop.

Collaborative research: academics should be fully aware of the obstacles and rewards of collaboration in research work. In the hands-on process, researchers highly benefit from the sum of creativeness, energy, and expertise contributed by each member of the research team. Academics who participate in the workshop, should feel the advantages of team work in a real-life experience. In order to accomplish this, the workshop facilitator may ask some participants to, individually, do a tiny literature review on a subject while others form groups to do the same task on the same subject. If the collaborative literature review works well, it is logical to expect that other tasks of researching could be as successful, if done collaboratively.

Multidisciplinary research: no doubt, the nature of today's research is cross- or multidisciplinary. By providing huge number of examples of multidisciplinary research reports, published in prestigious journals, the participants of this workshop can better understand the modern transformation of research conduct which has already become the trend in many academic contexts. More and more research funds are allocated to multidisciplinary research, and many journals prefer to publish the rich accumulation of knowledge from different aspects. Scholars from a variety of disciplines can share their expertise and capabilities whether in methodology, or in writing, submitting, and publishing the paper. It seems that academics must get used to multidisciplinary research, since it would be difficult for an individual author to compete with multiple authors.

Authoring and multi-authoring: naturally, researchers who collaborate in a research project expect, at least, their name to be published as a contributor to the

article. Academics, of any level or position, need to be aware that although co-authoring a paper is rewarding, it comprises a number of serious hidden issues which must be considered in advance before any unfair authorship takes place. This study has implications for novice researchers to learn about the principals of authorship and conflict management for co-authoring a research paper. A good co-authoring experience can result in encouragement of scholars to do more research projects collaboratively. A bad experience from co-authoring a paper can result in disappointment of the scholar and an isolation from collaborative research which is the accepted global norm today.

Researcher-author: the integration of writing and publishing processes is one of the pedagogical implications of this study. Writing and publishing are no two separate processes which the end of one is the beginning for the other. By introducing the concept of researcher-author in the present study, I want to emphasize the interrelatedness of researching (hands-on process) and publication (writing and publishing).

It is crucial for academics to publish in order for them to be heard. Gastel and Day (2016) attractively portrayed the importance of publication by posing a question:

> If a tree falls in the forest and there is no one there to hear it fall, does it make a sound? The correct answer is no. Sound is more than pressure waves, and indeed there can be no sound without a hearer (p.4).

Participants of this workshop must realize that a researcher-author is expected to have the knowledge of both conducting research and executing the writing-for-publication process. If we have academics who can do the research quite well, but are

not trained and tuned to publish their findings, definitely we have not supplied the real taste of research for them. Increasing the ranking of university and the KPI (Key Performance Indicator) which must be met by the academic staff through publication, is a strong leverage to encourage scholars and university students to become future researcher-authors.

Theoretical implications. Contributions to the two theoretical frameworks of the present study, complexity theory and parameters involved in writing, and general implications for the task of writing are provided in the following three subsections.

Complexity theory and text. Considering writing and publishing of a multidisciplinary multi-authored research article in science as a complex system, in which the produced text as a product-component is interdependently interacting with other components, is a new way of (to the best of my knowledge) looking at the production of an academic text. This study viewed complexity theory as a comprehensive framework for understanding the modern composition of text. It is not exaggerating to claim that for this study, in which an authentic task of writing a research article was executed by a team of multidisciplinary researcher-authors and the text was finally published in an on-line journal, the use of complexity theory was a suitable choice.

In analyzing a complexly-produced research article text, it was necessary to shift "from a theory about language alone, to a theory that can take account of different components of meaning" (Bearne, 2009). This study used complexity theory in looking at the processes of production and reporting the findings of a science research article, namely writing and publishing processes. The present study also contributes

to a completer understanding of the writing and publishing process of a multidisciplinary multi-authored research article as a complex system comprising interconnected components.

Most complex systems contain nested subsystems which are interacting with each other interdependently. And all components of the complex systems are in a continuous recursive interactions among themselves. Figure 5.1 displays a model of interaction between and among components of the complex system, while existing sub-systems are evident.

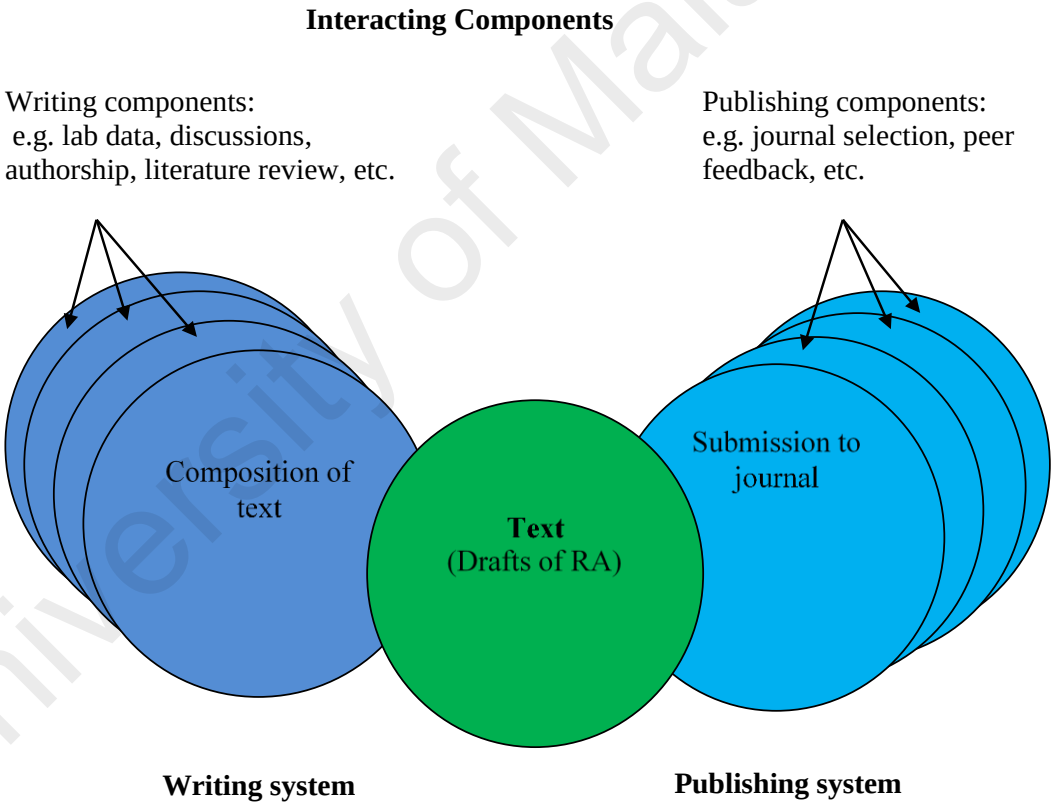

Figure 5.1. Interacting sub-systems in different levels and scales (adapted from Eppel, 2009; Larsen-Freeman & Cameron, 2008)

Structured variations and variation within structure. If someone is good at recognizing fruit trees from far, they would be able to guess the type of fruit that a tree would have. Meanwhile, it is almost impossible to predict the exact size, color, and

taste of the fruits. "The nature of a [tree as a complex] system may be characterized with reference to its constituent parts in a non-reductionist manner" (Manson, 2001).

The components' interactions and the system's behavior towards its environment are not fully predictable due to the dynamism, openness, non-linearity, and adaptiveness of complex systems. But in comparing chaotic systems and complex systems, "complex ones are less mechanical and more stable and predictable" (Schneider & Somers, 2006). Especially in complex systems where human agency is a component, some states of the system seem pre-planned by humans. In the present study, in the complex system of writing and publishing a multidisciplinary multi-authored research article the multiple authors, the journals' officials, and several other individuals involved in the process of writing and publishing comprised the human agents of the system. The authors were aware that after laboratory work, they would assemble the drafts and submit the final draft to their target journal. Therefore the co-authors could predict that the article would be published later.

Another manifestation of prediction, made by the research team, was receiving rejection from Journal A. From the very initial stages of their research project, the research team had reserved Journal B as their second target journal, in case Journal A would reject the manuscript.

Human awareness can also be considered as part of the predictability in complex systems. For instance, the authors of the research article were aware of their intended audience in both Journal A and Journal B. Therefore they provided color-coded graphs in reporting their findings. Not only the graphs were color-coded, the interpretations of the graphs were also based on the colored curves and lines in the graphs. I can conclude here that, audience-awareness which was a sub-component of

the writing process, was due to the predictability of the publication process. Examples like this and many other examples prove that not all complex system states and behaviors are chaotic and self-organizing. Instead, humans (as extant agents of the complex system) can determine the future moves of the system or even the type of interactions between and among components. The critiques of complexity theory highlighted this predictability which can result in emergence of structures within a chaotic system (e.g., Reitsma, 2003; Schneider & Somers, 2006). Regarding predictability, in some disciplines (such as genetics) scholars believe that even the amount of complexity in a system can be computed (Yockey, 2002).

In a recent critical review of Dynamic System Theory (DST), (Karimi-Aghdam, 2016) has asserted that "the past of an L2 system can be projected into the future of that system, making its onward developmental trajectory more or less predictable". From this point of view, the complex system investigated by the present study was not an exception in being predictable in some aspects. The writing and publishing process of the text of a research article in an L2 setting by ESL authors who had abundant experience in publishing scientific papers added to the predictability of the patterns within writing and publishing processes. This fact validates the criticism of the present study on the unpredictability of complex systems. Therefore this finding affirms that not all aspects, behaviors, and states of complex systems are always unpredictable.

Although the nature of the patterns and structures seem predictable in some complex systems, variation within structure still remains unpredictable as Larsen-Freeman and Cameron (2008) exemplify:

> When a sand pile avalanches, theory and description is not about individual grains of sand but about the behavior of the system as a

> whole. We can never know which particular grain of sand will produce the avalanche, but we do know that it will happen and about the nature of patterns of avalanches. Reductionist explanations are not possible because the behavior of every part of the system down to the atomic particle cannot be known (p.72).

The findings of the present study, especially from the publishing process, highlight the existence of certain patterns within the dynamic complex system of writing and publishing multidisciplinary multi-authored science research article. In general, complexity theoreticians support the idea that the interactions among and between the components and agents of a complex system are not predictable before the interaction or behavior takes place. On the contrary, some of the findings of this study display predictable patterns and structures in the ever-changing dynamic system.

There were sub-processes in the submission of the article to the two journals targeted by the research team from the initial stages of their research project (Journal A and Journal B). The expertise of the researchers in the team could anticipate the events such as rejection, acceptance, or further revisions. For instance, having a reserve journal (Journal B) proves the prediction of receiving rejection from Journal A. Yet, for the multiple authors of the article it was unlikely to fully predict the details about the exact re-action of the journal after each time of (re-)submitting the manuscript.

Possibility of manuscript rejection is also a predictable structure within the potential variations of the complex system behavior. But the approach that every journal applies in rejecting a manuscript could not be fully predictable, mostly due to the human beings involved in the process. Human agency is a highly dynamic, unpredictable component of the complex system which is potent to create as many

variations as possible in the interactions among components and in the behavior of the system as well. This indicates that, while some aspects of the system are predictable in the form of macro-level patterns, the emergence of micro-level interactions and behaviors still retain unpredictability.

Multiplicity of authors and the model of parameters involved in writing. In the writing of the multidisciplinary multi-authored research article in science, multiplicity of authors goes beyond doing a simple task of writing (done by a student in a class setting). One of the aspects not specifically considered in the model of "parameters involved in writing" by Grabe and Kaplan (1996) is the multiplicity of the authors. In this model the writer is the individual who has produced the written text. But in the present study in which several researcher-authors from different disciplines were the writers, the composition and structure of the produced text was much different from a single-authored text. So, the answer to "who" produced the text is slightly different from what Grabe and Kaplan have discussed. The model becomes, somewhat, more developed if the multiplicity of authors are considered too. Apart from having different cognitive characteristics, multiple authors in the present study were from different disciplines, thus their writing style and standards were also different from each other.

Today the concepts of "multi-authored" text and "multi-sited" research have gone beyond their original definition. New communication technologies have made everything possible. Even people are not only individuals, they are only a click away from millions of others to share their knowledge and ideas as well as being influenced by them. You may conduct a natural interview with your participant today and get an answer. But tomorrow (or even one hour after that) the same person will have a totally

different idea or much richer information about the question you asked. The source of new information could simply be his smartphone or his blog mates on the internet.

Big "C". Like the little "d" and big "d" proposed by Gee (1996), this study is suggests a similar concept for composition of text as little "c" and big "c". The first and foremost to mention here is that in the existing literature writing process is valued more for the physical act of writing or composing process. This is mostly true for simple tasks of writing which can be completed in a short period of time in class. The cognitive process of shaping the text in writer's mind is also reachable by analyzing think-aloud protocols. But, this may not be the case for authentic task of writing a research article, specifically when writing is influenced by various complex aspects such as multiplicity of authors, multimodality of text, and multidisciplinary content of the article.

Several processes help each other interdependently to move forward the process of writing a RA. Writer and his physical act of writing are not the only elements producing the text. Other processes within the research process have their own contributions and impacts on the text. It is more complex when RA is multi-authored. It seems that by growing new methods and demand of writing in new spaces "writing process" needs to be re-conceptualized. The present study taught researcher a new lesson. That writing process is more accurate if considered as:

"Writing process: Composing process + other processes".

By saying "other" processes, I mean that not all processes are predictable, until they emerge from researching the real-life writing experience.

Depending on the genre of the text, the composer of the text/the writer, and the audience other processes could be defined differently for various written texts. The

research process as the bigger umbrella or as big "C" (composition process) surrounds the act of writing (composing) process as the small "c" and it influences not only the process of writing but also its product which is the article. The writing process is one of the processes within the bigger process of research. I am going to expand the theoretical content of research article writing process with providing the fact that writing a research article occurs within a bigger process called research process. In fact, writing is one of the processes co-working and co-performing with other processes within the research process.

Suggestions for Further Research

It seems hard to claim that one's study is perfect and not affected by any limitations. But, as we learn from our mistakes, the limitations of the present study could provide excellent lessons for future researchers. Recommendations are presented here under methodological issues, and multidisciplinary research.

Methodological issue. One of the methodological limitations of this study was due to the sensitive delicate research site. When I asked Dr Janie for her CV in order to trace back her research background and also in order to have a better understanding of the research/writing process in her previous works, she refused to do so (she was unwilling to give me her CV). And since she was the main author and she gave me the entry permission to the group, no one else I could have access to their CV. So, I could not have access to the researchers' past experiences and the lessons they learnt previously. The researcher could not see how they had become (expert) authors.

Highly confidential and sensitive research site is not promising or encouraging. Researchers must be tough and possess high level of perseverance and tolerance. This one is not actually a limitation related to my study. Due to the nature of such research which has to deal with a lot of highly confidential data, data collection is very difficult.

Most of the co-authors did not allow recording of their voices, so I had to depend on my notes and memory. Immediately after leaving them I had to find a quiet corner and retrospect whatever I saw or heard in the sessions, meetings, interviews, or in laboratories. Obviously in such a sensitive research site I did not have the permission to video record anything. They were always afraid of data leak from my side, as an outsider, and this gave me discouraging feelings several times during my research.

To get information about the multiple authors' academic career, researcher looked for their names and affiliations in different websites especially the ones related to on-line journals. The findings showed that each of the authors had several publications whether co-authored or single-authored. Therefore, novice researchers who are seeking to collect data from research sites, it is not advised to start their first experience from a multi-authored research article.

Multidisciplinary research. Even though this study did not focus on comparing research process in science with research process in other disciplines, and as different disciplines have different approaches towards conducting research and reporting their findings, studying cases of different disciplines will add more insights into the current knowledge. So, in order to enhance the awareness-building among future researchers this study suggests them to conduct comparative studies on different disciplines, especially the ones in which publication has a high turnover (e.g. medicine, computer science).

A collection from the findings of studies on writing and publishing processes of research articles in different disciplines has the potential to be gathered in a comprehensive guidebook. This can greatly serve researcher-authors from variety of disciplines. The holistic awareness that such a guidebook can provide for

academicians would be very effective in production of more research papers and richer research findings in future.

References

Badley, G. (2009). Academic writing as shaping and re-shaping. *Teaching in Higher Education, 14*(2), 209-219.

Bakhtin, M. M. (2010). *Speech genres and other late essays*: University of Texas Press.

Barker, M. (2011a). Writing for publication for counsellors and therapists: part I. *Sexual and Relationship Therapy, 26*(1), 96-102.

Barker, M. (2011b). Writing for publication for counsellors and therapists: part II. *Sexual and Relationship Therapy, 26*(2), 191-198.

Barker, M. (2011c). Writing for publication for counsellors and therapists: part III. *Sexual and Relationship Therapy, 26*(2), 199-206.

Bearne, E. (2009). Multimodality, literacy and texts: Developing a discourse. *Journal of early childhood literacy, 9*(2), 156-187. doi:10.1177/1468798409105585

Belcher, D. D. (2007). Seeking acceptance in an English-only research world. *Journal of Second Language Writing, 16*(1), 1-22. doi:10.1016/j.jslw.2006.12.001

Bereiter, C., & Scardamalia, M. (2013). *The psychology of written composition*: Routledge.

Bezemer, J., & Kress, G. (2008). Writing in multimodal texts: A social semiotic account of designs for learning. *Written communication, 25*(2), 166-195.

Bogdan, R., & Biklen, S. (2007). Fieldwork. *Qualitative Research for Education: An Introduction to Theories and Methods: International Edition*.

Brown, C. L., Chan, K. C., & Chen, C. R. (2011). First-author conditions: evidence from finance journal coauthorship. *Applied Economics, 43*(25), 3687-3697. doi:10.1080/00036841003689739

Burgoine, T., Hopkins, P., Rech, M. F., & Zapata, G. P. (2011). 'These kids can't write abstracts': reflections on a postgraduate writing and publishing workshop. *Area, 43*(4), 463-469.

Burrough-Boenisch, J. (2003). Shapers of published NNS research articles. *Journal of Second Language Writing, 12*(3), 223-243.

Cameron, J., Nairn, K., & Higgins, J. (2009). Demystifying Academic Writing: Reflections on Emotions, Know-How and Academic Identity. *Journal of Geography in Higher Education, 33*(2), 269-284. doi:10.1080/03098260902734943

Carter-Thomas, S., & Rowley-Jolivet, E. (2003). Analysing the scientific conference presentation CP, A methodological overview of a multimodal genre. ASp 39-40: 59-72.

Casanave, C. P. (2005). *Writing games: Multicultural case studies of academic literacy practices in higher education*: Routledge.

Cheng, A. (2007). Transferring generic features and recontextualizing genre awareness: Understanding writing performance in the ESP genre-based literacy framework. *English for Specific Purposes, 26*(3), 287-307. doi:10.1016/j.esp.2006.12.002

Cheng, A. (2011). Language features as the pathways to genre: Students' attention to non-prototypical features and its implications. *Journal of Second Language Writing, 20*(1), 69-82.

Cheung, Y. L. (2010). First publications in refereed English journals: Difficulties, coping strategies, and recommendations for student training. *System, 38*(1), 134-141. doi:10.1016/j.system.2009.12.012

Cho, D. W. (2009). Science journal paper writing in an EFL context: The case of Korea. *English for Specific Purposes, 28*(4), 230-239. doi:10.1016/j.esp.2009.06.002

Clegg, S. (2005). Theorising the mundane: The significance of agency. *International studies in sociology of education, 15*(2), 149-164.

Coats, A. J. (2009). Ethical authorship and publishing: Elsevier.

Cohen, L., Manion, L., & Morrison, K. (2013). *Research methods in education*: Routledge.

Cooper, R. L. (1979). Language planning, language spread, and language change. *Language in public life*, 23-50.

Cortes, V. (2013). The purpose of this study is to: Connecting lexical bundles and moves in research article introductions. *Journal of English for Academic Purposes, 12*(1), 33-43. doi:10.1016/j.jeap.2012.11.002

Costino, K. A., & Hyon, S. (2011). Sidestepping our "scare words": Genre as a possible bridge between L1 and L2 compositionists. *Journal of Second Language Writing, 20*(1), 24-44.

Creswell, J. W. (2007). Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research.

Cuthbert, D., & Spark, C. (2008). Getting a GRiP: examining the outcomes of a pilot program to support graduate research students in writing for publication. *Studies in Higher Education, 33*(1), 77-88. doi:10.1080/03075070701794841

Cuthbert, D., Spark, C., & Burke, E. (2009). Disciplining writing: The case for multi-disciplinary writing groups to support writing for publication by higher degree by research candidates in the humanities, arts and social sciences. *Higher Education Research & Development, 28*(2), 137-149.

de Larios, J. R., Manchón, R., Murphy, L., & Marín, J. (2008). The foreign language writer's strategic behaviour in the allocation of time to writing processes. *Journal of Second Language Writing, 17*(1), 30-47.

Driscoll, J., & Aquilina, R. (2011). Writing for publication: A practical Six Step Approach. *International Journal of Orthopaedic and Trauma Nursing, 15*(1), 41-48. doi:10.1016/j.ijotn.2010.05.001

Dueñas, P. M. (2007). 'I/we focus on…': A cross-cultural analysis of self-mentions in business management research articles. *Journal of English for Academic Purposes, 6*(2), 143-162.

Duff, P. A. (2010). Language socialization into academic discourse communities. *Annual review of applied linguistics, 30*, 169-192.

Eisenhardt, K. M. (1989). Agency theory: An assessment and review. *Academy of management review, 14*(1), 57-74.

Eppel, E. A. (2009). The contribution of complexity theory to understanding and explaining policy processes: A study of tertiary education policy processes in New Zealand.

Erlen, J. A., Siminoff, L. A., Sereika, S. M., & Sutton, L. B. (1997). Multiple authorship: issues and recommendations. *Journal of Professional Nursing, 13*(4), 262-270.

Fakhri, A. (2004). Rhetorical properties of Arabic research article introductions. *Journal of Pragmatics, 36*(6), 1119-1138. doi:10.1016/j.pragma.2003.11.002

Flanagin, A., Fontanarosa, P. B., & DeAngelis, C. D. (2002). Authorship for research groups. *JAMA, 288*(24), 3166-3168.

Flick, U. (2014). *An introduction to qualitative research*: Sage.

Flower, L., & Hayes, J. R. (1981). A cognitive process theory of writing. *College composition and communication, 32*(4), 365-387.

Flowerdew, J. (1999a). Problems in writing for scholarly publication in English: The case of Hong Kong. *Journal of Second Language Writing, 8*(3), 243-264.

Flowerdew, J. (1999b). Writing for scholarly publication in English: The case of Hong Kong. *Journal of Second Language Writing, 8*(2), 123-145.

Flowerdew, J. (2008). Scholarly writers who use English as an Additional Language: What can Goffman's "Stigma" tell us? *Journal of English for Academic Purposes, 7*(2), 77-86. doi:10.1016/j.jeap.2008.03.002

Flowerdew, J., & Li, Y. (2009). English or Chinese? The trade-off between local and international publication among Chinese academics in the humanities and social sciences. *Journal of Second Language Writing, 18*(1), 1-16. doi:10.1016/j.jslw.2008.09.005

Floyd, S. W., Schroeder, D. M., & Finn, D. M. (1994). "Only if I'm first author": conflict over credit in management scholarship. *Academy of Management Journal, 37*(3), 734-747.

Galam, S. (2011). Tailor based allocations for multiple authorship: a fractional gh-index. *Scientometrics, 89*(1), 365.

Gallagher, C. W. (2014). Staging encounters: Assessing the performance of context in students' multimodal writing. *Computers and Composition, 31*, 1-12.

Gastel, B., & Day, R. A. (2016). *How to write and publish a scientific paper*: ABC-CLIO.

Gee, J. P. (1996). Discourses and literacies. *Social linguistics and literacies: Ideology in discourses, 2*, 122-148.

Geelhoed, R. J., Phillips, J. C., Fischer, A. R., Shpungin, E., & Gong, Y. (2007). Authorship decision making: an empirical investigation. *Ethics & Behavior, 17*(2), 95-115.

Gere, A. R. (1985). *Roots in the Sawdust: Writing to Learn across the Disciplines*: ERIC.

Geyer, R. (2004). *Europeanisation, complexity and the British welfare state*: Policy.

Ghivirigă, T. (2012). Scientific Articles in English in Economics Journals. A Case Study for Romania. *Procedia - Social and Behavioral Sciences, 46*, 4230-4235. doi:10.1016/j.sbspro.2012.06.232

Giddens, A. (2013). *The third way and its critics*: John Wiley & Sons.

Gillaerts, P., & Van de Velde, F. (2010). Interactional metadiscourse in research article abstracts. *Journal of English for Academic Purposes, 9*(2), 128-139.

Golafshani, N. (2003). Understanding reliability and validity in qualitative research. *The qualitative report, 8*(4), 597-606.

Gosden, H. (2003). 'Why not give us the full story?': functions of referees' comments in peer reviews of scientific research papers. *Journal of English for Academic Purposes, 2*(2), 87-101.

Grabe, W., & Kaplan, R. B. (1996). Theory and practice of writing: An applied linguistics perspective. *Harlow: Pearson Education*.

Grabe, W., & Kaplan, R. B. (2014). *Theory and practice of writing: An applied linguistic perspective*: Routledge.

Grassie, W. (2012). Many Windows: Reflections on Robert Ulanowicz's Search for Meaning in Science. *Axiomathes, 22*(2), 195-205.

Gregg, K. R. (2010). Review article: Shallow draughts: Larsen-Freeman and Cameron on complexity. *Second Language Research, 26*(4), 549-560.

Hernon, P., & Schwartz, C. (2007). What is a problem statement? : JAI.

Holmes, D. R., Jr., Hodgson, P. K., Nishimura, R. A., & Simari, R. D. (2009). Manuscript preparation and publication. *Circulation, 120*(10), 906-913. doi:10.1161/CIRCULATIONAHA.107.752782

Hyland, K. (2001). Humble servants of the discipline? Self-mention in research articles. *English for Specific Purposes, 20*(3), 207-226.

Hyland, K. (2002). Authority and invisibility: Authorial identity in academic writing. *Journal of Pragmatics, 34*(8), 1091-1112.

Hyland, K. (2003). Genre-based pedagogies: A social response to process. *Journal of Second Language Writing, 12*(1), 17-29.

Hyland, K., & Tse, P. (2005). Hooking the reader: A corpus study of evaluative that in abstracts. *English for Specific Purposes, 24*(2), 123-139.

Hyland, K., & Tse, P. (2012). 'She has received many honours': Identity construction in article bio statements. *Journal of English for Academic Purposes, 11*(2), 155-165.

Jick, T. D. (1979). Mixing qualitative and quantitative methods: Triangulation in action. *Administrative science quarterly, 24*(4), 602-611.

John, M. J. S. (1987). Writing processes of Spanish scientists publishing in English. *English for Specific Purposes, 6*(2), 113-120.

Karimi-Aghdam, S. (2016). A dialectical reading of Dynamic Systems Theory: Transcending socialized cognition and cognized social dualism in L2 studies. *Language and Sociocultural Theory, 3*(1), 55-82. doi:10.1558/lst.v3i1.27547

Keen, A. (2007). Writing for publication: pressures, barriers and support strategies. *Nurse Education Today, 27*(5), 382-388.

Koyalan, A., & Mumford, S. (2011). Changes to English as an Additional Language writers' research articles: From spoken to written register. *English for Specific Purposes, 30*(2), 113-123.

Kuteeva, M. (2011). Wikis and academic writing: Changing the writer–reader relationship. *English for Specific Purposes, 30*(1), 44-57.

Larsen-Freeman, D. (1997). Chaos/complexity science and second language acquisition. *Applied linguistics, 18*(2), 141-165.

Larsen-Freeman, D., & Cameron, L. (2008). *Complex systems and applied linguistics*: Oxford University Press Oxford.

Leuf, B., & Cunningham, W. (2001). The Wiki way: quick collaboration on the Web.

Li, Y. (2006). Negotiating knowledge contribution to multiple discourse communities: A doctoral student of computer science writing for publication. *Journal of Second Language Writing, 15*(3), 159-178. doi:10.1016/j.jslw.2006.07.001

Li, Y. (2007). Apprentice Scholarly Writing in a Community of Practice: An Intraview of an NNES Graduate Student Writing a Research Article. *TESOL Quarterly, 41*(1), 55-79. doi:10.2307/40264331

Li, Y., & Flowerdew, J. (2007). Shaping Chinese novice scientists' manuscripts for publication. *Journal of Second Language Writing, 16*(2), 100-117. doi:10.1016/j.jslw.2007.05.001

Li, Y., & Flowerdew, J. (2009). International engagement versus local commitment: Hong Kong academics in the humanities and social sciences writing for publication. *Journal of English for Academic Purposes, 8*(4), 279-293. doi:10.1016/j.jeap.2009.05.002

Lin, H.-I. (2003). *Learning to write the candidacy examination: Professors and students talking about academic genres and authorship.* The Ohio State University.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry* (Vol. 75): Sage.

Liu, Y. (2011). Power perceptions and negotiations in a cross-national email writing activity. *Journal of Second Language Writing, 20*(4), 257-270.

Lorenz, E. (1972). *Predictability; Does the Flap of a Butterfly's wings in Brazil Set off a Tornado in Texas?, sl: American Association for the advancement of science.* Paper presented at the 139th meeting.

Lund, A. (2008). Wikis: A collective approach to language production. *ReCALL, 20*(01), 35-54.

Macfarlane, B. (2017). The ethics of multiple authorship: power, performativity and the gift economy. *Studies in Higher Education, 42*(7), 1194-1210.

Macken-Horarik, M. (2004). Interacting with the multimodal text: reflections on image and verbiage in Art Express. *Visual communication, 3*(1), 5-26.

Manson, S. M. (2001). Simplifying complexity: a review of complexity theory. *Geoforum, 32*(3), 405-414.

Martın, P. M. (2003). A genre analysis of English and Spanish research paper abstracts in experimental social sciences. *English for Specific Purposes, 22*(1), 25-43.

Mason, M. (2009). Making educational development and change sustainable: Insights from complexity theory. *International Journal of Educational Development, 29*(2), 117-124. doi:10.1016/j.ijedudev.2008.09.005

Matsuda, P. K. (2003). Process and post-process: A discursive history. *Journal of Second Language Writing, 12*(1), 65-83.

Mercer, S. (2011). Understanding learner agency as a complex dynamic system. *System, 39*(4), 427-436. doi:10.1016/j.system.2011.08.001

Merriam, S. B. (1998). *Qualitative Research and Case Study Applications in Education. Revised and Expanded from" Case Study Research in Education."*: ERIC.

Morrison*, K. (2005). Structuration theory, habitus and complexity theory: Elective affinities or old wine in new bottles? *British Journal of Sociology of Education, 26*(3), 311-326.

Mungra, P., & Webber, P. (2010). Peer review process in medical research publications: Language and content comments. *English for Specific Purposes, 29*(1), 43-53.

Murray, D. M. (1999). *Write to learn*: Harcourt Brace College Publishers.

Negretti, R., & Kuteeva, M. (2011). Fostering metacognitive genre awareness in L2 academic reading and writing: A case study of pre-service English teachers. *Journal of Second Language Writing, 20*(2), 95-110.

Nordin, S. M. (2017). The best of two approaches: Process/genre-based approach to teaching writing. *The English Teacher*, 11.

Okamura, A. (2006). Two types of strategies used by Japanese scientists, when writing research articles in English. *System, 34*(1), 68-79. doi:10.1016/j.system.2005.03.006

Perneger, T. V., & Hudelson, P. M. (2004). Writing a research article: advice to beginners: ISQHC.

Pifarré, M., & Fisher, R. (2011). Breaking up the writing process: how wikis can support understanding the composition and revision strategies of young writers. *Language and Education, 25*(5), 451-466. doi:10.1080/09500782.2011.585240

Prior, P. (2013). *Writing/disciplinarity: A sociohistoric account of literate activity in the academy*: Routledge.

Reitsma, F. (2003). A response to simplifying complexity.

Richardson, L. (2000). Writing: A method of inquiry. InN. K. Denzin & YS Lincoln (Eds.), Handbook of qualitative research (pp. 923-948): Thousand Oaks, CA: Sage.

Royce, T. (2002). Multimodality in the TESOL classroom: Exploring visual-verbal synergy. *TESOL Quarterly, 36*(2), 191-205.

Samraj, B. (2005). An exploration of a genre set: Research article abstracts and introductions in two disciplines. *English for Specific Purposes, 24*(2), 141-156.

Samuel, M. (2005). *Perspectives on policy and practice in English language teaching*: Capital Corporate Communications Sdn Bhd.

Sandler, J. C., & Russell, B. L. (2005). Faculty-student collaborations: Ethics and satisfaction in authorship credit. *Ethics & Behavior, 15*(1), 65-80.

Schneider, M., & Somers, M. (2006). Organizations as complex adaptive systems: Implications of complexity theory for leadership research. *The Leadership Quarterly, 17*(4), 351-365.

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for information, 22*(2), 63-75.

Susser, B. (1994). Process approaches in ESL/EFL writing instruction. *Journal of Second Language Writing, 3*(1), 31-47.

Swales, J. (1990). *Genre analysis: English in academic and research settings*: Cambridge University Press.

Tardy, C. M. (2005). "It's like a story": Rhetorical knowledge development in advanced academic literacy. *Journal of English for Academic Purposes, 4*(4), 325-338.

Uzuner, S. (2008). Multilingual scholars' participation in core/global academic communities: A literature review. *Journal of English for Academic Purposes, 7*(4), 250-263.

Valle Jr, V. (2000). *Chaos, complexity and deterrence*. Retrieved from

Vanderberg, R., & Swanson, H. L. (2007). Which components of working memory are important in the writing process? *Reading and Writing, 20*(7), 721-752.

Welfare, L. E., & Sackett, C. R. (2011). The authorship determination process in student-faculty collaborative research. *Journal of Counseling and Development: JCD, 89*(4), 479.

Wray, K. B. (2002). The epistemic significance of collaborative research. *Philosophy of Science, 69*(1), 150-168.

Yarcheski, A., Mahon, N. E., & Yarcheski, T. J. (2012). A descriptive study of research published in scientific nursing journals from 1985 to 2010. *International journal of nursing studies, 49*(9), 1112-1121.

Yasuda, S. (2011). Genre-based tasks in foreign language writing: Developing writers' genre awareness, linguistic knowledge, and writing competence. *Journal of Second Language Writing, 20*(2), 111-133.

Yin, R. K. (2013). *Case study research: Design and methods*: Sage publications.

Yockey, H. P. (1977). A calculation of the probability of spontaneous biogenesis by information theory. *Journal of Theoretical Biology, 67*(3), 377-398.

Yockey, H. P. (2002). Information theory, evolution and the origin of life. *Information Sciences, 141*(3), 219-225.

Zamel, V. (1982). Writing: The process of discovering meaning. *TESOL Quarterly, 16*(2), 195-209.

Zutshi, A., McDonald, G., & Kalejs, L. (2012). Challenges in collaborative writing: addressing authorship attribution. *European Business Review, 24*(1), 28-46.