EDUCATIONAL COLLABORATION NETWORKS AND LEADERSHIP
IN CHILE AND LATIN AMERICA:
A SOCIAL NETWORK ANALYSIS

A Dissertation in
Educational Leadership and Comparative & International Education

by
Juan Pablo Queupil Quilamán

© Juan Pablo Queupil Quilamán

Submitted in Partial Fulfilment
of the requirements
for the Degree of

Doctor of Philosophy

August 2016
The dissertation of Juan Pablo Queupil Quilamán was reviewed and approved by the following:

Nona A. Prestine
Professor of Education
Dissertation Advisor
Co-Chair of Committee

Roger C. Shouse
Professor of Education
Co-Chair of Committee

Jacqueline A. Stefkovich
Professor of Education

Rachel A. Smith
Professor of Communication Arts and Sciences

Kai A. Schafft
Professor of Education
In Charge of Graduate Program in Educational Leadership
ABSTRACT

Collaboration has become an indispensable tool for promoting, improving and increasing investigation, and educational researchers are not outsiders to this phenomenon. However, little is known about collaborative efforts among educational scholars in Latin America. In order to address this gap in our knowledge, a Social Network Analysis (SNA) is used to examine the relationships and patterns that emerge from a dataset of co-authored scholarly publications among Higher Education Institutions (HEI) in Chile and Latin America, taking into account a purposeful dataset retrieved from Web of Science (WoS). Based on several sociograms and networks’ centrality indicators (density, degree, betweenness, and closeness), along with bibliometric results, this study focuses on detecting which educational actors are in positions of leadership in the collaborative networks, exploring the existence of clusters, and identifying what countries, institutions and scholars are acting as positive contributors in the collaborative network as a whole.

Thus, at the country level, it was found that 5 out of the 19 Latin American countries are totally unconnected within the collaborative network: Costa Rica, El Salvador, Honduras, Nicaragua, and Paraguay. Interestingly, most of them are smaller countries located in Central America. Conversely, bigger nations such as Mexico, Argentina and Brazil have higher number of publications along with respectable inter-country rates of collaboration. This situation allow them to display higher centrality indicators. The case of Brazil is outstanding, since it is the only country in the region where the official language is Portuguese. More surprisingly is the case of Chile, which is an isolated and relatively small country in South America; however, it presents the highest centrality indicators, leading the network in terms of degree centrality (number of direct connections among the actors of the network), betweenness (suggesting a strategic position on paths within the network), and closeness (interacting quickly with other actors in the network).

Even though Chile and the bigger nations of Latin America form a distinctive pattern of collaboration and leadership, the network as a whole has a density of 0.193, which means that only 19.3% of the potential connections occur in this network. This indicates that, at the country level, the network has the potential to improve its interconnectedness.

Taking into account the performance of Chile, additional analysis is conducted for this country at the institutional and scholar levels, along with an exploration of clusters (social groupings within networks), and the examination of the international dimension of the collaborative efforts at the scholar level.

At the institutional level, a total of 45 HEI were publishing papers, and 13 of them were not coauthoring educational articles through inter-institutional collaboration. In this case, the density of the
network is 0.0515 (5.15%). In other words, only 102 collaborative efforts between two or more institutions were actually made, among a potential total of 1,980 connections. In addition, a cluster analysis is appropriate for this large network. In this case, it was detected 7 different clusters that are grouping different institutions together. Most of these clusters seem to follow a geographical distribution, grouping universities from the central or central-south regions of Chile. Universities from either the extreme North or South regions are actually part of the group of unconnected institutions. Thus, Chilean universities that are leading collaboration also have the highest centrality indicators. These institutions are Pontifical Catholic University (PUC) and University of Chile (UCH). To a lesser extent, other institutions such as PUCV, USACH, and UDP also have leadership roles but within their own clusters. UDP is the only private institution established after 1981, following a major educational reform that allowed the creation of private HEIs, and with the exception of PUCV, all the mentioned institutions are located in Santiago, the capital city of Chile. Moreover, UCH and PUC are the oldest universities in the country, usually recognized for their long-traditions and prestige.

At the scholar level, researchers were ordered alphabetically and assigned to the same order that a Microsoft Excel sheet uses (i.e., A, B, C, ..., Z; AA, AB, ..., AZ; BA, BB, ..., BZ; ..., ZA, ZB, ..., ZZ; AAA, AAB, and so on). In order to detect a potential advancement of the network, the analysis was separated into two spans of time: between 1941 and 1999, and between 2000 and 2014. Before 2000, the network had a total of 83 scholars, and 35 of them were not coauthoring articles at all. This explains the low density of the network, with just 1.9% of the potential connections occurring. In addition, 14 clusters arose, but most of them involved either just 2 authors or just one article. In this regard, just one cluster (the bigger one) stands out over the rest, which actually contains the only leadership role detected – scholar VK– who is the only one with a betweenness centrality different than zero, and also has the highest degree centrality, along with the lowest farness (i.e., the highest closeness within its own cluster). Interestingly, most isolated scholars and those grouped in smaller clusters are located in Chile. The biggest cluster is mostly formed by scholars located abroad, with the exception of VK, who focus all their collaborative efforts with colleagues who are outside Chile.

Since 2000, a total of 635 scholars have been publishing papers, and 23 of them single-authored their articles. The network has a density of 0.009, which means that only 0.9% of potential connections were evidenced. However, taking into account the density of the network before 2000, the increase in the number of authors compared with the period before 2000 (from 83 to 635), and the decrease of unconnected scholars (from 35 to 23), it is possible to argue that, since 2000 the network achieved a respectable density. In addition, 112 different clusters (labeled from G1 to G112) were detected, most of them grouping 2, 3, 4 or 5 scholars. Nevertheless, some clusters group 11 to 80 scholars, representing several disciplines of subfields within educational research. Actually, in the bigger clusters, more intense
collaboration and leadership roles were detected: 15 scholars have a more significant role and relatively higher centrality indicators, having the ability to communicate and interact with other nodes from substructures within the network, even connecting some clusters. In this regard, the role of scholar QP was the most relevant. Furthermore, most collaboration is promoting international partnerships, taking into account that almost 70% of the clusters present at least one scholar located outside Chile, and most unconnected scholars are located within Chile.

Finally, 9 authors appeared in both analyzed periods of time, and 4 of them increased their centrality indicators, when the periods before and since 2000 are contrasted. QP is one of the researchers that appears in both periods. This scholar was the most prolific and coauthored all their articles (a total of 39).

The results of this study seem to indicate several patterns and factors that affect collaboration and leadership in the analyzed context. Firstly, when a zoom-in/zoom-out examination is executed (i.e., a global perspective, passing through country, institutional and scholar level analyses), with a special focus on Chile, each network appears to be apt for concentration of collaboration following particular patterns in different ways. Moreover, collaboration rates and sociograms vary greatly across the mentioned levels, where leadership roles align with few actors. Based on the analysis at the scholar level, it seems that networks increase constantly by the accumulation of new actors, and the latter preferentially join already well-connected actors and neighborhoods, forming disciplinary clusters or research fields.

On the other hand, the roles of geography, language, and technology seems to vary across levels. Thus, at the country level, most countries are connected—even Brazil, the only country where the official language is not Spanish. Nevertheless, most unconnected nations are smaller and located in Central America. For the Chilean case, most papers were found in journals where the official language is English (74%). Also, most unconnected universities are located in the extreme North or South regions of the country. Furthermore, most scholars located in Chile are collaborating with colleagues located abroad, probably supported by information and communication technologies (ICTs) and the globalization process around the globe. However, some policies seem to be necessary in order to improve collaboration and leadership across the analyzed networks.

Thus, regarding some policy implications of this study, forming successful educational partnerships should accommodate collaborative goals, and promote the modernization of institutional practices and a new sort of university faculty, highly motivated to collaborate with colleagues despite traditional and bureaucratic practices, based on a more broad and distributed leadership.

In addition, maps and networks of science and knowledge can help research actors to find places of their interest, since they provide global views of large amounts of knowledge. Thus, institutions and scholars can judiciously make use of the best knowledge sources, easily discover the best collaborators,
and quickly recognize the best research opportunities. For the Chilean case, the main issue is that there is a strong centralization of the educational research, mostly developed in the capital city, which may limit a larger impact of this knowledge on the entire society.

Despite the creation and development of several formal and informal organizations that promote collaboration at all levels (e.g., UNESCO, World Bank, Fulbright, etc.), it seems that most challenges and opportunities are based on either funding or leadership frameworks. Thus, since the mentioned unconnected countries in Latin America may be deprived of funds to sustain research colleges, it may be a reasonable option to develop a regional research-oriented university. In addition, Chilean and Latin American educational research may be supported by local funding as well as funding from abroad. Financial support models for the development of human capital is also necessary and initiatives such as Becas Chile seem to be appropriate for the Chilean context. To some extent, this policy provides more and appropriate leaders, which also depends on pertinent detection and leadership preparation. Thus, policies and training about scholars and institutional leadership roles may be outlined in order to develop new and dynamic leaders in the educational research field, such as promoting junior scholars’ participation and collaboration on several projects funded by public or private organizations.

Regarding future research about the topic of this study, its replication in other contexts and a subsequent comparison could be a reasonable suggestion for future work –especially if the evolution of the network for future spans of time becomes the focus of analysis. Additionally, mapping journals instead of authors would provide several disciplinary maps. Citation, co-citation and inter-citation analysis also appear to be relevant for the Latin American and Chilean context, in order to evaluate the impact of research from local scholars in the academic world within specific fields.

The analysis of who is the first author on collaborative articles is another area that justifies further research and analysis. Also, a bibliometric analysis would be interesting to examine the relationship between the countries with more associations, partnerships, collaboration or other kinds of interactions (e.g., Chile with the United States). Semantic web and semantic network analysis are other ways to examine patterns of research, in order to improve knowledge management. Finally, mapping coauthored educational research and authors’ expertise, career or trajectory, based on their personal bibliography files, may be a novel way to examine the evolution of the researchers’ role. A special focus on the involvement of women in the profession may be interesting in this regard.

In summary, this study aims to provide a better understanding for collaboration and leadership in large-scale networks, using SNA techniques for the visualization of the collaborative environment among researchers, with a special focus on the Chilean context. The results of this kind of study may be useful and interesting for policymakers, institutions, researchers, educators, and practitioners involved in the promotion and development of more and better collaboration and leadership among higher education
institutions that investigate educational topics. For the Chilean case, collaboration through co-authorship is a reasonable way to intensify the quantity and quality of papers in the educational field. In fact, this study reveals a perceptible upward trend of collaborative research, based on the results of coauthored efforts reported in major ISI-indexed journals. The dynamism and other characteristics of collaboration and leadership within the discipline have been detected. Thus, the findings of this study can be helpful in research planning and the improvement of policies at the institutional and country levels. They may support the accomplishment of a more efficient and effective organization and management of information resources and services among the actors that develop educational research in the Chilean context, which in turn can assist the evolution of leaders that facilitate multi-authored research activities.
# TABLE OF CONTENTS

List of Figures ................................................................................................................................... x

List of Tables ................................................................................................................................... xi

Acknowledgements ............................................................................................................................ xii

Chapter 1 Introduction ....................................................................................................................... 1

I. Background .................................................................................................................................. 1
II. Purpose ...................................................................................................................................... 2

Chapter 2 Literature Review .............................................................................................................. 4

I. Social Networks .......................................................................................................................... 4
II. Leadership ................................................................................................................................. 6

Chapter 3 Theoretical Framework .................................................................................................... 8

I. Social Networks .......................................................................................................................... 8
II. Leadership ................................................................................................................................. 10

Chapter 4 Research Methodology .................................................................................................. 13

I. Bringing collaboration, social networks, and leadership together ........................................ 13
II. Research Approach .................................................................................................................... 15
III. Research Design ....................................................................................................................... 16
IV. Site and Sample Selection ......................................................................................................... 16
V. Research Strategies .................................................................................................................... 17
VI. Data Collection Techniques ..................................................................................................... 18
VII. Data Analysis Techniques ....................................................................................................... 20
VIII. Reliability and Validity ............................................................................................................ 25
IX. Methodological Limitations ...................................................................................................... 26

Chapter 5 Results ............................................................................................................................ 29

I. Bibliometric and Descriptive Statistics ...................................................................................... 29
   Collaboration at the country level ............................................................................................... 29
   Chile as a case study ................................................................................................................... 31
   Chilean articles by language and number of authors ............................................................... 31
   National and international collaboration for the Chilean case .................................................. 33
   Journal collaborative distribution ............................................................................................... 35
   Inter-institutional collaboration .................................................................................................. 36
   Collaboration at the scholar level ............................................................................................... 37
II. Leadership and the Development of Cooperation ................................................................ 42
   Leadership at the country level ................................................................................................. 42
   Leadership at the institutional level .......................................................................................... 45
   Leadership at the scholar level .................................................................................................. 47
   Leadership roles before 2000 .................................................................................................... 49
   Leadership roles since 2000 ...................................................................................................... 54
# III. Summary

- How strong is the collaboration network in the publishing of educational research papers in Chile and Latin America? .......................... 63
- To what extent do Chilean and Latin American Higher Education Institutions engage on inter-institutional collaboration surrounding educational publications? ................. 64
- What are the patterns of collaboration between institutions and researchers in the Chilean and Latin American context? ................................. 66
- What are the national and international patterns of leadership of Chilean and Latin American educational research papers? ................................. 70

Chapter 6 Conclusions .......................................................................................................................... 78

# I. Major ideas and inferences

- Collaboration and leadership from a network perspective .............................. 79
- The role of geography, language, and technology .............................................. 84
- Globalization and Internationalization of research .............................................. 87

# II. Policy Implications

- Forming successful partnerships ................................................................. 90
- Increasing flows and platforms of knowledge .................................................. 92
- Challenges and opportunities ................................................................. 96

# III. Recommendations and Future Research

- Funding and monetary issues ................................................................. 99
- Development and role of leading educational actors ...................................... 101
- Future research ......................................................................................... 105

REFERENCES ................................................................................................................................. 110

Appendix A Countries collaborating with Chile in Educational Research ................... 125
Appendix B Chilean Institutions in the Collaborative Network ....................................... 126
Appendix C Identification of authors based on number of appearances before and since 2000 .......... 128
Appendix D Scholars of each cluster within the Collaborative Network since 2000 ............ 129
LIST OF FIGURES

Figure 4-1. Sociogram where A is the sociometric star ................................................................. 21
Figure 4-2. Matrix representation of Figure 4-1. ........................................................................... 21
Figure 5-1. Between-country collaboration and total publications per country .................................. 30
Figure 5-2. Distribution of articles between 2000-2014. .................................................................. 32
Figure 5-3. Average number of authors per paper in 2000-2014. ..................................................... 32
Figure 5-4. Distribution of papers among type of journals. ............................................................... 35
Figure 5-5. Number of papers per institution .................................................................................. 36
Figure 5-6. Latin American collaborative network .......................................................................... 43
Figure 5-7. Chilean Institutional collaborative network ..................................................................... 45
Figure 5-8. Scholars’ collaborative network for the Chilean context before 2000. .............................. 49
Figure 5-9. Collaborative network before 2000 based on scholars’ location .................................... 53
Figure 5-10. Scholars’ collaborative network for the Chilean context since 2000. ............................. 55
Figure 5-11. Collaborative network since 2000 based on scholars’ location ..................................... 60
LIST OF TABLES

Table 5-1. Total published articles based on number of authors per article. ...............................................33
Table 5-2. Articles written based on number of authors per article including national or international collaboration. ................................................................................................................34
Table 5-3. Number of authors based on number of appearances before and since 2000. ...................38
Table 5-4. Amount of authors based on number of appearances and location before and since 2000. ....39
Table 5-5. Total published articles based on number of authors per article before and since 2000. .......40
Table 5-6. Number of papers for authors that appear before and since 2000. ........................................41
Table 5-7. Social network centralities by country. ............................................................................................44
Table 5-8. Social network centralities by institution. .........................................................................................46
Table 5-9. Social network centralities by author before 2000. .................................................................50
Table 5-10. Social network centralities by author since 2000. .................................................................56
Table 5-11. Social network centralities by author before and since 2000. ...............................................57
I would like to thank every member of my dissertation committee, and by extension, I would like to express my gratitude to the faculty and staff of the Educational Leadership Department and College of Education at Penn State. They have been a source of inspiration and support for my work during every semester that I have been in State College.

I have also to express my gratitude to the Chilean government and Fulbright organization for giving me the opportunity to study abroad. This has been a great experience, which also was supported by several friends I have met while abroad, learning a different language, adapting to a new climate and so on. In this regard, I am very grateful to people living and working in State College, the Latin American community group LAGRASA –for which I was lucky to be its Vice-President–, the increasing Chilean chaps, and my musical band “Los Tikis”. The friendship and fun we had was helpful during my time spent on research and thesis writing.

Finally, my sincere appreciation goes to my relatives, parents, sister and brother for their lifelong support. My eternal gratitude to my wife, Elizabeth. She has been the best source of care and love during this adventure.

To all of them, many, many, many thanks.
Chapter 1
Introduction

I. Background

Networks are an effective way for bridging the boundary between any kind of organization. Specifically, networks can be seen as a source of knowledge and also a platform for collaboration, especially on the academic world. When this collaboration occurs this phenomenon is called the “invisible college” (Crane, 1972; Zuccala, 2006), and most researchers have visualized such community by bibliometric approaches. For instance, White and Griffith (1982) worked in an author co-citation analysis to explore the structure of a specific research community. Similarly, Klavans and Boyack (2010) exposed a map of science at different levels, ranging from researchers to nations, by co-citation analysis. In this sense, bibliometric research has identified groups of scholars mutually interacting, and productive researchers from geographically distant sites who exchange information to monitor progress in their field.

Among on the many different meanings of collaboration in academia, co-authorship of articles has become one of the main ways of expanding knowledge through a fruitful relationship based on shared academic interests (Katz & Martin, 1997). These shared interests can be discovered and portrayed by social networks techniques (Schwartz & Wood, 1992). Actually, these communities can be hidden, undetected, or simply used in an implicit way (Adamic & Adar, 2005; Juszczyszyn & Musiał, 2009).

In fact, scholarly publication and their impact on rankings have had a remarkable influence across higher education institutions all around the world and education faculties have not been exempt from these ramifications either (Post, Stambach, Ginsburg, Hannum, Benavot, & Bjork, 2013; Fischman, Alperin, & Willinsky, 2010). One strategy that higher education institutions have developed to respond to and survive in the current climate of publishing pressure is to invest in partnerships that are concerned with the development of empirical research (Altbach, 2007). Increasingly, these partnerships have acquired an international, cross-disciplinary and team orientated approach (Baker, 2004). Therefore, this process builds on certain existing collaborations between the universities.

With the significant development of communication technologies and globalization, collaborative communities can be easily developed. However, while most studies have focused on
collaborative structures in specific scientific communities, the utilization of such collaboration has not been deeply analyzed in the educational field, as well in developing countries in a comparative way, taking into account that collaboration could be developed beyond the boundaries of each society. In addition, few studies have analyzed collaborative networks in education at the tertiary level, and also the analysis is scarce about what kind of leadership is found in these networks. Actually, most studies link collaboration or social networks with distributed leadership at the school level (for instance, Hadfield & Jopling, 2012). In other words, there is a shortage of methods and tools that help us understand the magnitude and extension of scholarly collaboration and the involved and executed leadership in it (Hoppe & Reinelt, 2010).

By applying a network view, researchers can analyze the structure of an invisible community structure of an organization in a clear and visible form (Wasserman & Faust, 1994). In this sense, Social Network Analysis (SNA) methods can provide insightful information towards the extension of collaboration networks in several HEI settings. Chile, and Latin America in general, present an interesting and relevant case study to examine the potential of the SNA to understand higher education collaborations and emerging leadership at the institutional and scholar levels.

II. Purpose

The purpose of this research is to use Social Network Analysis to describe the levels of inter-institutional collaboration and leadership for higher education institutions. I look at Chile and Latin America as a specific case study. In this process, I understand collaboration as the joint participation in the publication of peer-reviewed articles addressing educational issues. Thus, collaboration can be analyzed at the individual level (in this case, educational scholars), group level (e.g., joint publications among group of scholars), organizational level (i.e., higher education institutions), and national level (in this case, Latin American countries).

Specifically, this study will address the following questions:

a. How strong is the collaboration network in the publishing of educational research papers in Chile and Latin America?

b. To what extent do Chilean and Latin American Higher Education Institutions engage on inter-institutional collaboration surrounding educational publications?

c. What are the patterns of collaboration between institutions and researchers in the Chilean and Latin American context?
d. What are the national and international patterns of leadership of Chilean and Latin American educational research papers?

This study attempts to explore the use of collaboration networks for the development of the research in education from an innovative perspective using Social Network Analysis. This study will evaluate both the collaboration patterns and leadership development, specifically the extent to which HEI collaboration and leadership are executed in Chile and Latin America.
Chapter 2

Literature Review

I. Social Networks

The network notion is one of the important paradigms of the modern era. Lewin (1936) and Moreno (1934) started to investigate the ‘field’ or ‘space’ of social relations and its features as a network. Moreno referred to this method as ‘sociometry’ and also invented the ‘sociogram’ as a way of visually representing social networks with point and lines. Lewin’s work influenced a mathematical approach to social interaction and was key on graph theory studies, which helped to transform the study of social networks from description to analysis. Gradually, sociometry became a major field of research in education (Jennings, 1948; Gronlund, 1959), community studies (Lundberg & Lawsing, 1937), and other areas such as biology, linguistics and psychotherapy.

The development of powerful computers allowed the analysis of huge networks in order to discover new insights regarding connectedness and social structure. As a consequence, one of the beauties of the social network approach is the potential to analyze network relations with an increasing range of programs, algorithms, and methods that give a diagram and also relevant data about the features of the analyzed networks and its nodes, such as the density of the network, and the degree, betweenness and closeness centralities of each actor of the network. A series of comprehensive books and handbooks (Degenne & Forse, 1999; Knoke & Yang, 2008; Schensul, LeCompte, Trotter, Cromley, & Singer, 1999, Scott, 2000; Wasserman & Faust, 1994) illustrate these and other commonly used methods that are distinctive of the social network analysis.

The network approach allows scholars to detect the interactions of any individual unit within the larger field of action to which units belongs. Even more, one of the benefits of the network approach to organizational studies is the extent to which the same network topics and methods apply at different levels.

Nevertheless, despite the effects that social networks can have on the lives of individuals and institutions, much social science research has been silent regarding social influences, except for some theories in social impact or social influence notions (e.g., Friedkin, 1998; Friedkin & Johnsen, 2011; Latané, 1981, 1996). Actually, in the field of organizational behavior, the prevalence of individualistic perspectives has contributed to the neglect of social influences.
Accordingly, most studies show little about the establishment and development of the social structure of actors, and how the interactions among actors affect several outcomes.

In response to this neglect of social structure and interactions among actors, an increasing number of studies have been written about social network analysis at the organizational level (Andrews & Knoke, 1999; Grandori, 1999; Gulati, Diadkin, & Wang., 2002; Nohria & Eccles, 1992), and about other relevant levels, such as the intraorganizational and interorganizational levels (Krackhardt & Brass, 1994; Raider & Krackhardt, 2002; Baker & Faulkner, 2002).

One of the relevant networks to analyze in modern organizations are the collaborative networks, which usually are embedded in several settings, especially in knowledge-based institutions such as universities. These organizations could fail to establish essential connections with other institutions, which implies to suffer from the ‘liability of unconnectedness’, in other words, the incapacity to contribute in the continuing processes of learning and innovation that lead to institutional growth (Powell, Koput, & Smit-Doerr, 1996).

Nevertheless, most studies regarding collaborative networks in the educational field are based on school contexts (Coburn & Russell, 2008; Daly, 2010; Penuel, Riel, Joshi, Pearlman, Kim, & Frank, 2009). In these studies, social network theory provides a powerful analytical framework and mechanisms that allow for a detailed investigation of the nature, antecedents, and outcomes of teacher collaboration. Outside of education, SNA have indicated the significance of social networks for organizational performance and innovation (e.g., Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998) and suggested useful principles for the design of effective initiatives to enhance the value of collaboration (e.g., Cross, Borgatti, & Parker, 2002).

Kilduff and Tsai (2003) stated that the “need to know more about how embeddedness within networks of ties can constrain and enable firm behavior,” putting the focus to the mix of cooperation, and also competition, that has come to distinguish the contemporary organization behavior. One example in this issue is the study of Gulati and Gargiulo (1999).

Despite the numerous applications of social network analysis, modern scholarly networks seem to be a field of recent exploration by few researchers. For example, Burt (1987) used a network of physicians as his research background to explore the context of innovation diffusion (other recent example can be found in White, 2011).

In sum, one of the attractive features of networks approaches to organizational studies is the range in which the same network topics and procedures apply at diverse levels (Kilduff & Tsai, 2003).
II. Leadership

In education, social network research can be used to shed light on concepts such as (distributed) leadership, professional learning communities, teacher collaboration, reform implementation, and teacher induction, among others (Moolenaar, 2012). In this sense,Muijs, West, and Ainscow (2010) present an interesting summary of these and other standpoints, which explore the relationships between leaders and other actors in their own organizations and beyond.

Consequentially, several studies have linked either collaboration and leadership or SNA and leadership in educational settings. However, most of this research is based on school contexts, examining variations in the origins and purposes of school networks (Muijs, West, & Ainscow, 2010), but certainly some findings could be extrapolated to HEIs backgrounds.

For instance, Spillane and Kim’s study (2012) points to the important role that informal teacher leaders play in brokerage among subgroups, more so than formal leaders. They found that formal leaders’ participation in networks was not always associated with the norms that would promote instructional improvement, such as trust and collective responsibility. Moolenaar, Sleeegers, Karsten and Daly (2012) found that networks may be more centralized around a few influential, informal leaders in some Dutch schools than in others. On the other hand, there is an increasing use of shared and team leadership perspectives (Kaser & Halbert, 2005; Wohlstetter, Malloy, Chau, & Polhemus, 2003). Nevertheless, there are few studies that take into account the interaction between different kinds of networks on leaders’ professional development, identity formation and overall effectiveness (Hadfield & Jopling, 2012).

According to Hadfield and Jopling (2012), due in part to the increasing popularity of social network analysis, their methodologies have allowed researchers to map how leaders interact and position themselves in networks within schools (Spillane, 2005) and between schools in a locality (Daly & Finnigan, 2010). At an extensive theoretical level, networks have been analyzed and taken into consideration about the degree to which leadership is a social phenomenon or is located in individuals that could be detected across individuals and groups (Spillane & Orlina, 2005).

In addition, Hadfield and Jopling (2012) indicate that most studies in educational leadership have tended to found its debate of how leaders develop relationships with others on interpersonal constructs, such as reciprocity and trust (e.g. Coleman, 2011; Hargreaves, 2011). In contrast, when applied to other types of organizations, social network analysis tends to have a broader theoretical background that includes the relationships between network connections and issues of power and collective action (Krackhardt, 1990; Simpson & Macy, 2004). All these
works give insight into the complex organizational dynamics around educators or scholars, leadership, and educational change. Thus, taking into account the academic and higher education institutions contexts for this study, leadership is conceptualized in terms of making change or altering institutional trajectories, i.e., the way institutions would develop by their organizational characteristics and members’ roles, which goes beyond the persistent application of the authority of individuals in leadership positions (Johnstone, 2011).

In this study, I will analyze the leadership performance of educational actors and their positions in structured networks at the country, institutional and scholar levels, taking into account several rates of collaboration in co-authorship publications in the educational field. The critical role of leadership in knowledge-creation organizations such as universities is to promote an innovative HEI for the common good, and this could be achieved by collaboration networks through scholars’ relationships inside and outside their institutions. In other words, the leaders should act as hubs and “bridgers” of the collaborative network (Tashiro, Lau, Mori, Fujii, & Kajikawa, 2012), connecting several followers’ scholars, and by extension linking different institutions, in order to lead the educational scholars’ communities.
Chapter 3
Theoretical Framework

The expansion and utilization of knowledge that responds to the needs of the present century requires HEIs with organizational structures that are based on the principle of collaboration. Accordingly, deep analysis of the collective work of scholars and their institutions based on SNA is essential to improve the current models for better research outcomes.

Two theoretical frameworks, social networks and leadership, have emerged in the educational research literature that present leadership for institutional change and innovation efforts in terms of actions related to the organizations’ missions of development and dissemination of knowledge and emphasize the importance of social interactions for their enactment.

I. Social Networks

Social Networks Analysis (SNA) has become a cutting edge field, and its potential application to several organizations is enormous, shedding light at many different levels of examination.

According to Kilduff and Tsai (2003), the network of connections within which people are embedded may have significant consequences on the success or failure of their projects. Consequently, SNA can illuminate several organizational phenomena, such as collaborative educational research, across micro to macro levels. Even though it is arguable that network ties have many positive effects, it is important to note that preserving and increasing relationships with people requires resources that can be difficult for some groups of people to afford (Riley & Eckenrode, 1986).

For Freeman (2004), social network analysis is a scientific community with a recognizable intellectual lineage and clusters of researchers based in several centers and loosely linked by cross-cutting collaborations and intercitations. This implies that SNA can perfectly analyze the patterns of collaboration in any field of knowledge. Accordingly, this study explores the use of collaboration networks in the development of the research in education from an innovative perspective that offers Social Network Analysis.
Conceptually, Freeman (1979) suggested that one can use degree centrality to measure communication activity, betweenness centrality to calculate control benefits, and closeness centrality to estimate questions of independence and efficiency. Network constraint refers to the degree to which an ego is limited by its network connections, and network density represents the overall connectivity of the network (Burt, 1992). Unlike a centrality measure, network constraint captures the possibility of opportunism since the constraint measure gauges the conditions that make it possible to be opportunistic and manipulate the flow of information (Burt, 1992).

According to Scott and Carrington (2011), the heart of social network analysis is the graph theory, which was the origin of studying networks of all kinds as being graphs composed of point and lines. Actually, SNA is a specific application of graph theory in which individuals and other social actors, such as institutions, are represented by the points and their social relations are represented by the lines (the main idea of Moreno’s sociograms).

On one hand, working relationships among colleagues apparently can be developed by establishing successful institutionalized structures in HEIs. Taking into account that a relationship can be considered a consequence of recurrent patterns of interactions that bring positive outcomes, reinforcing effective working/operational relationships have the benefit of expanding collaborative efforts. On the other hand, collaboration can be potentially undermined through either the absence or a deficient formal structure of collective practices.

As a consequence, there has been an increasing interest in the ideas of corporate community and also the networked organization (Haythornthwaite & Wellman, 1998). While some studies have focused on collaborative structures in the scientific community, the utilization of such collaboration is not limited by the boundaries of a specific institution. Actually, collaboration can go beyond these boundaries and even can be seen in other sectors of society. Moreover, the recent advances in global communication networks have changed the nature of community, and the online community can be considered as a social community (Wellman, 2001). With the development of communication technologies, collaborative communities can be easily developed within and across organizations.

Thus, social network analysis can, for instance, indicate levels of entrepreneurship in particular interdisciplinary groups. Additionally, social networks can emphasize the natural interactive attributes of leadership acts and academic collaborative efforts. This is strongly influenced by the resources embedded in this kind of social relationship –especially knowledge, influence and personal support–, which bond the concrete power that frame organizational action. Moreover, Social Network Analysis offers a research methodology that facilitates the study of the
patterns of social interactions that reinforce the execution of leadership tasks within organizations and across institutions (Borgatti, Jones, Everett, 1998).

II. Leadership

According to Day (2011), in the last decade social networks and social capital (defined by Burt (1997) as a person's location in the social structure or hierarchy) have been considered one of the key factors of leadership development among leadership scholars. Actually, most usual theoretical assumptions take as their starting point an investigation linking leadership and social network analysis (Brass, 1984; Brass, Galaskiewicz, Geve, & Tsai, 2004; Kilduff & Tsai, 2003), and these research studies may see schools as organizations basically defined by the quality and pattern of the interactions that occur within these institutions.

From such theoretical assumptions, leadership is developed around notions of facilitation, brokerage, and exchange between different networks and actors (Hadfield & Jopling, 2012). Brokerage and facilitation of the various ‘communities’ that exist both in and outside schools, have appeared regularly in categories of the key functions of school leaders (Hargreaves, 2003; Kubiak, 2009; Little, 2005; Veuglers & O’Hair, 2005). Apparently, these ideas can be also envisaged in higher education settings.

Thus, social network analysis can be integrated into leadership examination to provide an alternative way to understanding leadership effectiveness (Balkundi & Kilduff, 2006). In fact, the unique methodologies of SNA research can be quite useful in helping to understand the development and evolution of leadership networks. Even more, the study of educational leadership can also be based on a better understanding of the structural characteristics of networks and their interactions, especially how they shape leaders and how leaders use the structural characteristics in order to exert their influence (Hadfield & Jopling, 2012).

To study leaders’ agency within networks, Hadfield and Jopling (2012) suggest works on organizational research that consider how network interconnections and transitions influence leaders (e.g., Balkundi & Kilduff, 2006; Mehra, Dixon, Brass, & Robertson, 2006). They also suggest starting to explore changes in individual and collective purposes triggered by networking and how these are related in some specific situations with the development of more extensive, or ‘collective’, professional identities, which emerge when individuals build particularly strong identification with a local setting, community or network. In educational institutions, this is only mentioned indirectly in the literature, in terms of developing ‘ownership’ (Worrall & Noden, 2006) or a ‘sense of belonging’ (Wohlstetter et al., 2003) of networks and network initiatives.
In this context of scholarly collaboration, the idea of leadership is defined in terms of actions and processes as the strategy and promulgation of tasks comprising the detection, acquisition, distribution, organization and use of social, physical and cultural resources linked to the core work of the system (Spillane, 2006). Specifically, distributed leadership theory emphasizes that the execution of leadership acts encompasses numerous players that transcend formally assigned leaders and that they do so in multiple social patterns that range from centralized to distributive.

Several studies have discussed leadership and networks. Balkundi and Kilduff (2006) mentioned that not only a two-way flow of communication with followers but also an appropriate position in a networked organization are essential factors for leaders to effectively navigate the followers. In this sense, Hannah and Lester (2009) stated that leaders who develop knowledge catalysts in bridging positions will have the greatest influence on the diffusion of knowledge. Some authors have proposed that centrality measures are related quantitatively to leadership (Mullen, Johnson, & Salas, 1991), and other studies have qualitatively argued a relationship between leadership and network structure (Hannah & Lester, 2009; Hoppe & Reinelt, 2010).

Network structure and centrality measures are considered to relate to the leadership performance of entities. Balkundi and Kilduff (2006) discussed how a network influences leadership. Accordingly, four main principles interrelate network structure with leadership. Firstly, leadership refers to the relationship connecting individuals instead of an attribute of individuals. Second, people usually are entrenched in a network and their views of others as leaders are revealed through sets of embedded connections within which people are located. Third, network relations constitute social capital, which is valuable for developing and improving leadership. Fourth, network structure is considered to represent a communication arrangement in an organization that results from leadership of individuals. Thus, in order to understand who is a leader from a network perspective, it is necessary to investigate the social-structural positions that certain individuals have in the analyzed social setting. Although several network measures have been suggested to represent a position of actors in a social network, centralities are considered as relevant measures of leadership (Balkundi & Kilduff, 2006; Mehra, Kilduff, & Brass, 2001; Mullen et al., 1991).

The specific methodologies of social network analysis can be reasonably useful in helping leadership researchers understand the development and evolution of leadership networks. Actually, and according to Li (2013), an outstanding feature of network analysis is that it allows scholars to display network visualization. One example is the method applied by Hoppe and
Reinelt (2010), who used pictures to illustrate the evolution of leadership networks, basically showing separate images of networks over various points in time. An additional approach for demonstrating dynamic networks and leadership is to plot summary statistics over time (Doreian, Kapuscinski, Krackhardt, & Szczypula, 1996).

Even though several studies have been made to clarify the structures of communities, only a few studies have analyzed collaboration efforts in specific scholars’ networks (e.g., White, 2011), and even less studies have been carried out in the educational field at the level of institutions and individuals embedded in the network in a comparative way. Accordingly, this study attempts to fill the gap of knowledge in these issues, providing an examination for a different but interesting scenario: the collaborative efforts in the educational sphere among Higher Education Institutions in Chile and Latin America.
Chapter 4

Research Methodology

I. Bringing collaboration, social networks, and leadership together

An incipient objective of researchers in different fields of science is to expand our understanding of the contextual, dynamic and organizational features of technological, biological, and social networks (Barabási, 2014). In this sense, the field of education should not be an exception.

With the emergence of modern technologies of communication, collaboration among scholars seems to have increased over the last few decades. As a consequence, newer relationships within and across countries have emerged.

Although some research has analyzed the reasons and factors that promote these scholarly collaboration efforts under different perspectives (Anderson, 2007; Austin & Baldwin, 1991; Mattessich & Monsey, 1992; Procter, Williams, Stewart, Poschen, Snee, Voss, & Asgari-Targhi, 2010), little is known about the patterns of collaboration between institutions and researchers within and beyond specific societies. Even more, most of these analyses have put their focus at the individual level, although these scholarly collaborative efforts are executed essentially in a relational manner. As some authors have highlighted, people are basically relational beings (Barnett, 2011; Gergen, 2009). Accordingly, despite the availability of some public datasets that provide scholarly productivity information, such as Web of Science, Scopus and SciELO, most of this data is used in a descriptive way, in order to quantify the number of articles or books that have been developed by certain higher education institutions. Behind this are usually ranking purposes and increasing the prestige of these organizations through publications in top journals.

Social network analysis (SNA) is a research approach that uses mathematical measures and visualization techniques to represent the configuration of connections between people, organizations, their interests or goals, and other social units within a system of interest. In this chapter, I describe essential social network concepts and their applications to analyze the educational co-authorship network within Latin American countries, and the role of Chile in this network, along with the cooperative relationship of Chilean scholars within the country.
According to previous research, SNA may be a valuable evaluation tool for this kind of study (Scott & Carrington, 2011).

On the other hand, fostering and spurring leadership networks is increasingly the center of leadership development efforts (Balkundi & Kilduff, 2006; Hoppe & Reinelt, 2010), especially those seeking to develop leadership with the ability to impact policy and generate social and systems progress. Therefore, understanding the structure of networks and changes in them is an essential aspect of leadership development analysis.

In theory, associations based on voluntarism—such as a co-authorship or collaborative efforts—should not be dominated by any single actor. One would expect coworkers working together to solve solutions on an equal basis, though issues of personal power, unequal status between colleagues, or even unequal leadership capacities may alter it (Muijs, Ainscow, Chapman, West, 2011). It has also been argued that collaboration between schools is correlated to more distributed forms of leadership, both enabling these and being enabled by them due to opportunities for leadership available in these collaborations (Ainscow, Muijs, & West, 2006). Hence, a similar question can be asked whether the same is true for higher education institutions. There is evidence from education and other fields that leaders play a key role in the establishment of networks (see, for example, Silvia & McGuire, 2010; McGuire & Silvia, 2009).

In practice, most successful networks are driven by a small group of activist leaders, given permission to lead by colleagues, and with a more distributed approach can be adopted later (Hadfield, 2007; Chapman & Harris, 2004). Similarly, the development of leadership roles specifically related to network leadership creates a group of people with experience in leadership systems, and thus will likely advance naturally in future networking (Hadfield, 2007; Fullan, 2004). Leadership in networks may be purposely developed or may emerge from a strong need or desire among persons to connect (Hoope & Reinelt, 2010). In collaborative scholars’ networks, some studies have showed that specific attributes of scholars help to boost their leadership role, such as university, seniority, tenure, etc. (Lungeanu, Huang, & Contractor, 2014). Although this is common in the science field in developed countries, little is known about it in the educational field, especially in the context of developing countries.

In this sense, understanding and measuring networks can inform policymakers and other stakeholders about the advantages and disadvantages to being connected, especially in the “academia environment,” taking into account that the development and dissemination of knowledge is important for all societies. Given the relevance of collaboration in educational research in Chile and Latin America, this field is significant to analyze in order to gain more and
better research, and then obtain significant implications that can lead improvements and strategies in this area. Thus, SNA data analysis may highlight a specific area for improvement in the existing leadership of the collaborative network and underscore the need for policies such as emerging leaders programs.

II. Research Approach

This study aims to quantify the structure and evolution of scholarly co-authorship efforts into a network structure.

During the last years, different approaches have been used to collect, organize, and analyze academic knowledge and proficiencies (White, 2011). One interesting approach that can be used to describe and make sense of scholarly knowledge is using co-authorship data from a major digital library through Social Network Analysis. The way in which I will address this study will allow me to identify the foremost institutions, scholars, and research areas and specific locations in which network research is led, developed, and conducted.

In this sense, social network analysis (SNA) comprises a set of theories, tools, and methods for understanding the relationships and structures of several networks. The main concepts utilized in SNA are the notions of “nodes” and “links”. In general, the “nodes” of a network are the people and the “links” are the relationships between people. Nodes are also used to represent events, ideas, objects, or other social units. Thus, SNA experts collect network data, analyze the data with distinctive SNA software, and often produce sociograms (i.e., maps or pictures) that display the patterns of connections between the analyzed nodes of the network.

In a similar manner, research in bibliometrics and scientometrics (Börner, Chen, & Boyack, 2003; Chen, 2013) aims to analyze, map, and study the science field by systematic means. Recently, scientometric techniques have been extended to deal with very large datasets (Boyack, Klavans, & Börner, 2005; Klavans & Boyack, 2006). In this study, SNA visualization techniques are applied to interlink and analyze co-authored papers on a large scale. The resulting visualizations can be utilized to identify leading experts and institutions in a research area of interest, such as the educational field, within a specific setting, such as the Latin American and Chilean context.

Thus, a co-authorship network is the product of the professional links between several entities. For this study, three levels of analysis are considered, since entities can be represented by countries, higher education institutions or researchers.
In general, in this kind of collaboration network, the co-authorship decision could be made entirely by the authors, i.e., decision making is located at the level of individual nodes (Barabási, Jeong, Néda, Ravasz, Schubert, & Vicsek, 2002). This gives support to performing a focused analysis at the individual level.

### III. Research Design

The formulation of an inquiry directly impacts the strategies that one employs to address the phenomenon involved. Thus, co-authored articles and leadership configurations may be formed deliberately, or they may arise from a major inclination or demand among individuals or leaders to connect with one another (Hoppe & Reinelt, 2010).

According to Yin (1981), the case study strategy has among its strengths the ability to cover both a contemporary phenomenon and its context. Following the research design of previous studies (Barabási et al., 2002), I will single out the collaboration network as a case study, mainly because I need a specific network for which a dataset is explicitly available, along with a particular span of time. In other words, case study is relevant for this research because this topic covers a phenomenon that appears to be inseparable from its context.

To quantitatively evaluate co-authorship efforts in Latin America, especially in Chile, I present this case study as a novel research design, where several graphs represent co-authorship relations, along with SNA indicators of leadership role within each network. As one can note, Social Network Analysis and visualization techniques are collectively applied to this case study. Thus, the graphic representations of the networks are applied to encode the co-authorship relations in the used dataset as well as their impact.

In sum, Social Network Analysis (SNA) will be used to improve the awareness of leaders about the influence of networks, to advance in the driving of connections, and to reinforce the capacity of the network to act cooperatively. This seems reasonable when one analyzes collaborative networks, such as this case study.

### IV. Site and Sample Selection

Latin America offers the opportunity to study and analyze the structure and evolution of successful co-author efforts in the educational field. In this context, the past few decades have witnessed a steady interest in raising the quality of education, embodied not only in the equitable
access to education but also in the development of professional education that includes the activity of science, technology and innovation (Maldonado-Maldonado, 2009).

To study the structure and evolution of successful co-authorship teams, I will draw upon the Web of Science (Wos) dataset. This dataset is unique since it contains a vast range of educational articles and papers from different parts of the world by different single or co-authored teams, published in recognized educational journals around the globe in several languages. Accordingly, I will be retrieving data out of a well-known and reliable data source, using several filters and processing procedures in order to obtain related data to Latin America and Chile, followed by data transformation based on SNA techniques.

Summary statistics for the used dataset indicate that more than 5,200 papers were co-authored within Latin America between 2000 and 2014, including around 400 publications co-authored by Chilean higher education institutions. Interestingly, the number of authors by article across this span of time has steadily increased, supporting the relevance of this kind of study. As well, a co-author team could publish just one article or more. Regardless of this fact, every collaborative effort is equally significant in the analyzed network, hence repeated efforts will be considered.

V. Research Strategies

There is an increasing digital coverage and storage of knowledge, along with a rapid advancement in algorithmic development and computing power. Accordingly, a range of comprehensive maps of different educational fields can be generated directly for research, policymaking, and other practical purposes.

A general feature of SNA studies is that they usually analyze specific systems, and often describe different kinds of networks through sociograms or mapping graphs, whose nodes are individual entities and links represent various quantifiable social interactions.

In this way, one can test some properties of the analyzed networks. For instance, most networks have the so-called small world property (Watts, 1999; Kochen, 1989), which means that the average separation between the nodes is rather small, i.e., one can find a short path along the links between most pairs of nodes. On the other hand, real networks usually display a degree of clustering higher than expected for random networks (Watts, 1999; Watts & Strogatz, 1998).

Nowadays, most scholarly knowledge is commonly developed and stored in forms such as papers or articles. Authors who jointly publish one paper are said to “coauthor” it. These
entities (scholars) and link types (co-authorship or collaboration) are a good way to represent scholarly knowledge.

Accordingly, this study uses author nodes (excluding authors who published single author papers exclusively) and coauthorship links. The edge width (the breadth of a link) is based on the number of coauthored articles.

In addition, articles commonly have diverse attributes, such as publication date and topics. Authors usually have an address with an institution and location data. Because authors and papers are associated, the location and institution of an author can be attributed to the author’s papers. In the same way, the publication date and topics can be associated with a paper’s author. Consequentially, statistics such as the number of papers or co-authorships per author can be obtained over time.

Based on the position of a country, institution, or researcher in a coauthorship network, attributes such as node degree –indicating the number of coauthorship efforts–, or betweenness centrality –counting the number of shortest paths between nodes that pass through a node– can be computed (Freeman, 1977). The former is an indicator of a “major player”. The latter is an indicator of a “gatekeeper” role.

The co-authorship network of educational scholars represents a prototype of evolving networks. In addition, for the Chilean case, it offers one of the most extensive databases to date on social networks, when one contrasts it with other disciplines’ databases. By mapping the electronic database containing all relevant coauthored articles in educational journals for a 14-year period (2000–2014), I will infer the dynamics, the structural mechanisms, and the leading roles that rule and manage this kind of social network in a developing country context.

VI. Data Collection Techniques

One task in this research is to define the type of data to be used. The principal types of data are “attribute data” and “relational data” (Wellman & Berkowitz, 1997). The former is related to the characteristics of the nodes as individuals or groups, which can be measured, quantified and analyzed through several statistical procedures, such as variable analysis. The latter refers to the ties and connections that relate one actor to another, and because these relations are not properties of the actors themselves, the appropriate method of examination is network analysis. In addition, social structures are built from relations, which is a concern within the sociological field, but surprisingly few research methods and data collection procedures focus on relational data (Scott, 2000).
Nowadays, several scholarly databases are available for the general public and researchers. While some are reasonably large, none of them cover all of mankind's scholarly knowledge, and some of them are considered objective, “global” collections produced by publishers, compared with the more subjective and “local” personal bibliographies or questionnaires (Börner, 2007). The latter are usually limited by the money and time available to obtain and examine questionnaire data.

In this sense, the citation indexes published by Thomson Scientific's Web of Science (http://isiknowledge.com), also known as WoS, are one of the best sources of bibliographic records on major journal publications, including a multilingual database (Chadegani, Salehi, Yunus, Farhadi, Fooladi, Farhadi, & Ebrahim, 2013). In fact, this database provides all entity and link information for this kind of study.

Regarding the way to find relevant records, Börner (2007) argues that “without context, intelligent data selection and quality judgments become extremely difficult” (p.810). In this sense, Latin America, and particularly Chile, offers a scenario that deserves to be studied, taking into account the consolidated knowledge-based society in developing countries, along with the fact that Latin American universities have a critical role in the production and dissemination of knowledge (Torres & Schugurensky, 2002).

In addition, this study just takes into account articles in the educational field, which have not been deeply analyzed in previous research. Accordingly, some keywords can be used in a purposeful manner. Thus, based on previous bibliometric studies (Cruz-Ramírez, Escalona-Reyes, Cabrera-García, & Martínez-Cepena, 2014), three categories of research were used to search for relevant articles for analysis: Educational Research, Special Education, and Educational Psychology. The span of time considered in this query will be 2000-2014, in order to shed light on the patterns of collaborative co-authored articles within Chile and Latin America in the beginning of the 21st century, thereby recognizing the potential of connectivity –and collaboration among people– in the current era.

It is important to underscore that co-authored efforts assume an undirected relationship. This means that a connection between \( i \) and \( j \) is present if either \( i \) co-author with \( j \) as well \( j \) co-author with \( i \). In other words, co-authorship does no take place in a specific manner, taking into account that \( i \) and \( j \) are co-authors of the same article.
VII. Data Analysis Techniques

Given the relevance of several datasets that store scientific production, in particular Web of Science database, which provides information on coauthorships, and the significance of social networks for knowledge dissemination, bibliometrics and SNA methods are steadily becoming an important technique in the analysis of scholarly knowledge in natural science fields (see for instance, Barabási et al., 2002; Bordons & Gómez, 2000; Borner, 2007).

Regarding the main techniques of SNA, on one hand, a graph (also called a sociogram) is a theoretic notation of the linkages among the actors of a network. In other words, a graph can be considered as a scheme of the network in order to visualize the connections (lines, ties or edges) among the entities or actors (nodes) that are part of a specific social network. This innovation is derived from Moreno’s work (1934) as a method of representing the formal characteristics of social configurations, analogous to those of spatial geometry.

This kind of visualization technique is an interesting way to picture a network. In this regard, it is important to mention that this research focuses on one-mode network data, in other words, one that is generated by structural variables measured on a single set of actors, through a model for a social network with an undirected dichotomous relation (i.e., co-authorship of articles). Consequently, for this study the main edge attributes will be the relation type (co-author) and weight (frequency of co-authorship).

For Moreno (1934), social networks had specific and marked structures, and the construction of these structures into a sociogram allows scholars to visualize the canals through which, for instance, cooperation could flow from one person to another and through which one individual could influence another. Moreno also argued that the mapping of sociograms allows for examiners to detect leaders and isolated individuals, to identify reciprocity and asymmetry, and to draw channels of connections. He stated the concept of a “sociometric star,” which is the recipient of many and recurrent choices from others and who, consequently, held a position of influential status and leadership (Scott, 2000). This can be visualized in Figure 4-1 in a hypothetical co-authorship network where scholar A is the sociometric star. Here it is relevant to introduce the concept of matrix, which makes it possible to study the members of a social system and many types of ties through the use of computer software such as UCINET or PAJEK, among others (Wellman & Berkowitz, 1997; Scott, 2000). Usually, computer storage is binary (1/0) where the presence of a tie is represented by 1 and the absence of a tie is represented by 0. Figure 4-2 represents the respective matrix associated with Figure 4-1. Since nodes do not have ties to
themselves, this is also represented by a zero. Therefore, all values on the diagonal of the matrix are equal to zero.

In a similar way, Lewin’s work (1936, 1951) delineated that group behavior has to be seen as affected by the field of social forces in which the groups are situated. Thus, Lewin asserted that the structural characteristics of this social space can be examined through the mathematical techniques of topology and set theory. From a topological perspective, the social field is seen as a set of points connected by paths. These points, as in a sociogram, can illustrate individuals, their actions, or their purposes, while the paths can represent the interactional or causal sequences that relate the points.

![Figure 4-1. Sociogram where A is the sociometric star.](image)

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 4-2. Matrix representation of Figure 4-1.

It is important to highlight that creating SNA maps depends highly on how people perceive them. Hence, it is useful to take into account the work of Perer (2008), who provides the means to graph large networks, and also offers a clear procedure to refund the appropriate methods currently used to generate network diagrams.
On the other hand, building from Lewin’s work, the attempts to apply mathematics to the structure of group relations were developed by Cartwright, Zander and Haray, modeling social pressure, group cohesion, cooperation, power and leadership (Cartwright & Zander, 1953; Cartwright & Haray, 1956). For instance, the mentioned scholars delineated the basic notion of illustrating groups as collections of points linked by lines, which is the basic insight of Moreno. They also argued that the resulting diagram could be analyzed by using the mathematical ideas of graph theory, whose axioms and formulae describe the characteristics of the patterns established by the lines between nodes, which was a major advance in a sociological direction.

Mitchell (1969) added a set of terms, resulting from a transformation of graph theory into sociological language, which can be used to describe some properties of social networks. Density, for instance, can be seen as the fullness of the network, i.e., the degree to which all potential relations are actually present. Reachability refers to how easy it is for all actors of a network to contact one another through a restricted number of linkages. Furthermore, Barnes (1969) added cliques and clusters as concepts for identifying social groupings within networks.

In sum, and taking into account the previous research, the major commonly used metrics to visualize leadership issues of an undirected network, such as a collaborative network, are nodal degree, closeness, and betweenness centralities (Wasserman & Faust, 1994).

In a non-directional graph, a nodal degree is a measure of the “popularity” of an actor. In other words, it indicates the direct connections of an actor \( n_i \) to other members of the network. The formula to calculate this estimation, \( d(n_i) \), is the following:

\[
d(n_i) = \sum_{j \neq i} x_{ij}
\]

In the previous formula one can find the number of nodes adjacent to the analyzed actor. In other words, \( x_{ij} \) is 1 if node \( i \) is connected to node \( j \) and 0 otherwise. In addition, the normalized degree centrality of a node is the previous formula divided by all the possible connections. Thus, if a network has \( N \) nodes, in order to normalize \( d(n_i) \), this should be divided by \( (N-1) \).

Betweenness centrality focuses on the benefits of nonredundant network paths to members. In other words, it evaluates strategic positions on paths, either in a liaison or broker roles. Accordingly, it determines the average number of shortest distances (or geodesic paths) that use node \( n_i \). Its mathematical representation is the sum of estimated probabilities of a shortest path between two actors (for instance, nodes \( j \) and \( k \)) that include a given actor (for instance, node
i) over all pairs of actors. Therefore, the formula for the normalized betweenness centrality of node \( n_i \) is:

\[
B(n_i) = \frac{\sum_{j<k, i \neq j, i \neq k} g(n_i)_{jk}}{\left(\frac{(N-2)(N-1)}{2}\right)}
\]

In this formula, the numerator represents the number of geodesics linking \( j \) and \( k \) that contain \( i \) in between, all this divided by the total number of geodesics linking \( j \) and \( k \). The denominator represents the maximum possible value for betweenness. For instance, if a node has a betweenness centrality equal to zero, this means that this node does not act as an intermediary in the interaction between two other nodes.

Finally, closeness centrality centers on how quickly a node interacts with others (i.e., reachability). In other words, it is the distance of a node to the rest of the network. Its mathematical representation denotes “farness”, i.e., the reciprocal sum of the shortest distances (geodesic paths) from one node to the other nodes. In fact, the formula for the normalized closeness of node \( n_i \) is the following:

\[
C(n_i) = \frac{N-1}{\left(\sum_{j=1}^{n} d(n_i, n_j)\right)}
\]

In this case, \( d(n_i, n_j) \) is the shortest distance from node \( i \) to node \( j \). For instance, if a node has the lowest closeness centrality within a network, this means that this node has the highest sum of the shortest distances (geodesic paths) from one node to the other nodes. In other words, it has, in total, the longest distance of a node to the rest of the network.

All these measures focus on actors’ locations in a network, and all of them try to quantify the importance of an actor inserted into a network (Wasserman & Faust, 1994). Additionally, there are also measures for the analysis of the entire network. The most common is called network degree or density. This determines the number of lines incident to each node in a graph. Consequently, for a network where \( N \) represents the number of nodes and \( L \) is the number of lines or connections present in the network, density \( D \) is calculated by the following formula:

\[
D = \frac{2L}{N(N-1)}
\]

For example, a network with a density \( D=1 \) means that all possible connections among nodes are present, i.e., 100% of the linkages are visible in the respective network graph.
Nevertheless, density is especially prone to misinterpretation when comparing networks of different sizes. Therefore, it is also recommended that one uses *links per node* as a measure of network connectivity, a more intuitive measurement than density (Hoppe & Reinelt, 2010).

I will use all the distinctions noted above in my analysis, and many other metrics can be derived from them. For instance, bridgers are individuals in a network who have connections to different clusters. When one analyzes leadership in a network, bridgers provide relevant options for remodeling, expanding, and providing payoffs, basically because they have direct paths to several viewpoints, concepts, opinions, and networks that are otherwise left unexplored by most network actors (Hoppe & Reinelt, 2010).

Finding bridgers in a network is typically achieved through calculating betweenness centrality (Freeman, 1979). This calculation indicates how often an individual is likely to be an important relay point between other network members. Thus, high betweenness centrality indicates bridging.

A cluster is a strongly knit-bonded subgroup; in other words, it is a subset of nodes interconnected by links (Barabási et al., 2002). Identifying clusters is considered one of the most important applications of SNA, since it reveals important, formerly-recognized subgroups. Clusters can be visualized using network maps and algorithms that identify clusters measure variations in density and links per node. In sum, a cluster is a local region within a network with relatively high density and relatively few links to other clusters. Wasserman and Faust (1994) and Brandes and Erlebach (2005) review some mathematical definitions of clusters and provide algorithms for finding them.

Academic knowledge collected by organizations such as Web of Science can be denoted, interlinked, organized, and analyzed using SNA techniques. In fact, this data can be analyzed and diagramed in diverse ways to support findings and sense making. Thus, nodes and links can be analyzed at the local level (in this case, in order to identify authors that have a gatekeeper role), at the sub-network level (such as to determine all subgroups in the Chilean educational field), or at a country level (in order to detect the status of Chile within Latin America and also the most predominant connections), taking into account the international scholar community when co-authored articles are considered.

In addition, the mentioned dataset can be used to identify leaders and primary experts, based on the number of papers published, the number of coauthors, as well as their positions and roles within the network.
Thus, for example, nodes that have a high degree, closeness, and betweenness values or that were mentioned frequently in the dataset can be labeled and ranked by the name of the country, university, or researcher. The size of the node could correspond to the number of times the name has published an article, or could also be one of the previously mentioned centrality values.

In order to investigate the emergence of subgroups within coauthorship networks, I will measure the comparative size of the largest cluster, r, giving the ratio between the number of nodes in the largest cluster and the total number of nodes in the network. This is pertinent for larger systems with a higher number of nodes, such as co-authorship at the university and at the researcher level.

The number of papers co-authored by a set of scholars might well be a signal of the impact of a coauthorship team (Börner, Dall'Asta, Ke, & Vespignani, 2005). Accordingly, it is important to underscore that because I am interested in the role of authors and their interaction in the co-authorship networks, only co-authored papers are considered in each calculation.

There is a growing body of research about what to evaluate when assessing networks (Durland & Fredericks, 2006). In this sense, through the previously described metrics, one can focus on understanding and measuring leadership roles in specific networks and identifying the most influential actors within networks.

VIII. Reliability and Validity

In order to understand leadership in different networks, Hoope and Reinelt (2010) argue that a common evaluation topic is connectivity, and SNA is particularly useful for assessing connectivity and leadership within networks, taking into account that SNA emphasizes which actors are central or external participants of the network, recognizes where bonding and bridging are developing, and detects who has a strong impact in the network. In addition, introducing bridging and bonding to organizational leadership networks has been demonstrated to improve leadership performance (Burt & Ronchi, 2007) and similar benefits may be observed in other leadership network settings.

On one hand, SNA maps or sociograms can provide a new perspective on how the pieces of a network fit together. Accordingly, policymakers or persons in charge of an organization could, for instance, reorient leadership development focus from individuals to the collective leadership system, taking into account how leadership acts individually and collectively is relevant for collaborative networks such as co-authorship systems.
On the other hand, SNA metrics can provide evidence of greater sharing and collaboration at three main levels: across countries, higher education institutions, and researchers. When one combines these metrics with mapping visualization, it is possible to detect *bridgers* in the network, along with the actual and potential alliances, and whether the network itself is contributing to positive changes and creating more and better collaborative efforts. Hoope and Reinelt (2010) argue that a “network framework” allows one to identify different types of leadership and the outcomes typically associated with each type of network.

The influence of SNA has become perceptible in its use as an orientating notion and its specific body of techniques. Certainly, SNA takes into account specific theoretical approaches towards the structure of the social world (Scott, 2000). Hence, the application of formal mathematical ideas and theorems to the study of social networks exposes actual implications of the model that might otherwise not have been detected or operated by the designer of the model (Barnes & Harary, 1983).

During the last decade, computer software for social network analysis has increased their capacity for inquiry. They provide several statistics that allow researchers to determine the appropriate reliability and validity of the results in the executed analysis. A researcher can contrast the results from two or more different software in order to address possible concerns of replication of the investigated outcomes.

On the other hand, to achieve high accuracy, automatic techniques have to be combined with manual efforts, taking into account that the data comes from a huge dataset. Thus, the database preparation is critical to assure the accuracy of the analysis. Data cleaning (data cleansing), one of the most common pre-processing steps, is necessary to ensure database quality and consistency. These pre-processing steps include the detection and correction of corrupt or inaccurate records from the database. It includes records in which the same entity or agent under analysis appears with different identifiers or names (e.g., Univ. A, University A, U.A.), incomplete records, duplication of records, or invalid records (e.g., negative year of publication). Generating a quality database is important, especially for large networks and low level analysis (at the individual level).

**IX. Methodological Limitations**

This stated approach allows an ample and deep comprehension of networks in context. Thus, this framework offers a method for network analysis, but not the best scenario for which networks should aspire.
Another restriction of this study is that currently a database that includes all of mankind's scholarly knowledge does not exist. As well, some studies confirm an overlapping of Google Scholar, Scopus, and Web of Science for diverse subject areas, especially for citation tracking research (Bakkalbasi, Bauer, Glover, & Wang, 2006; Jasco, 2005).

In addition, in this era of proliferation of disciplinary specialization, it could become a limitation trying to identify emerging interdisciplinary research in the educational field in Latin America as well as in Chile, mainly because it is challenging to detect appropriate search phrases to retrieve all significant papers from vast datasets available online. Thus, even though the coverage of the Web of Science database is ample, this methodology is restricted by the ability of the researchers or practitioners to make appropriate search queries, which could become a nontrivial task for interdisciplinary or emerging research areas and studies.

It is important to be aware that the process of research generation is not simple or direct. Research typically starts out from isolated or loosely interconnected entities of research, and that is likely one of the reasons that collaboration is really valued in the academic world, but little is known about the patterns of these efforts in the educational field.

On the other hand, research results are usually published in diverse ways and places. Commonly, after an important period of time, research strands interconnect, joint scientific conferences for general or specific disciplines are held, and several journals are created. In this sense, it is worth remarking that this study does not include other forms of research collaboration, such as books, manuscripts, theses, and conference proceedings, among others.

For this kind of study, some authors (Barabási et al., 2002; Newman, 2001) mention some methodological issues that could affect the data analysis, especially at the individual level. For instance, two different authors with the same initials and surname will appear to be the same node in the database. Thus, there is a source of error in distinguishing some scholars. On the other hand, occasionally a given author uses one or two initials in different articles or journals, and in such cases the scholar will appear as separate nodes. However, Newman (2001) revealed that these kinds of problems are of the order of a few percents of error.

Finally, another limitation of this methodology is that, at the individual level, I ignore the aging of nodes—which could reflect the fact that researchers retire and stop publishing articles—and presume that all actors and connections existing in the network are operative, and particularly competent to create and obtain new connections. However, this is a reasonable assumption, taking into account that the time-span over which data is analyzed is shorter than the typical professional lifetime of a researcher.
Regardless of the previously mentioned limitations, I do not expect that they will have a significant impact on this study’s results, mainly because bibliometrics and SNA methodologies and techniques have been successfully tested and implemented in several research areas, which provides support to this study and others with similar characteristics.
Chapter 5

Results

I. Bibliometric and Descriptive Statistics

Research activities in Latin American countries seem to enjoy increasing development, spurred by several global trends, such as the increasing economic value of knowledge and the constant demand for scholars to work on academic activities in new ways (Bernasconi, 2008). In the case of the educational field, this trend is also supported by legislations from several reforms, advancements in technology and datasets, and the study of educational equity and quality within societies (Palamidessi, Gorostiaga & Suasnábar, 2014). However, little is known about the progress of educational research in Latin America –especially in Chile–, which is reflected mainly in the form of publications in journals and books or conference presentations. The lack of analysis on these issues at different levels may inhibit the use of appropriate frameworks and policies regarding the actions that researchers, colleges, and policymakers can enhance in order to promote an effective collaboration. Such collaboration could eventually improve the quality of research, which in turn could reveal and stimulate the expansion and distribution of leadership roles among scholars, institutions and countries.

Collaboration at the country level

For the analysis at the country level, and because the focus is on Latin American nations, the retrieved dataset used a query with the following countries: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay, and Venezuela (in alphabetic order). In addition, and taking into account the advance of globalization and technology in the current century, an emphasis has been put on works published since year 2000.

Thus, 5,204 publications fulfilled the above criteria. This dataset allows for the identification of patterns of collaboration among Latin American countries. In total, there were 244 collaborations among the analyzed countries. The highest amount of collaboration can be found between Argentina and Mexico (14), followed by Brazil-Mexico (13), Argentina-Chile (10), Colombia-Mexico (9), Chile-Colombia (7), Cuba-Mexico (7), Brazil-Chile (5), and Brazil-Cuba (5). On the other extreme of this spectrum, there are countries that do not collaborate with other nations from the region, such as Costa Rica, El Salvador, Honduras, Nicaragua, and
Paraguay. Nonetheless, these countries have published a respectable amount of works, taking into account their size. The between-country collaboration based on total publications per nation is showed in Figure 5-1.

![Figure 5-1. Between-country collaboration and total publications per country.](image)

In the previous figure, countries were ordered based on their total publications (largest to smallest). In this regard, remarkable patterns can be observed. First of all, the general collaboration among Latin American countries could be considered relatively low (almost 5%). For instance, the countries from the region that publish more are Brazil (over 2,400 publications) and Mexico (almost 1,200 works), but they have at the same time the lowest rate of inter-country collaboration among Latin American countries (2% and 4%, respectively). On the contrary, countries such as Guatemala, the Dominican Republic, Panama, and Ecuador have inter-country collaboration rates above 15%. However, each of these countries have less than 25 publications. In other words, they have on average 2 publications where inter-country collaboration can be found.

In this regard, the cases of counties such as Cuba, Colombia and Chile are more fascinating. On one hand, Cuba has the highest inter-country collaboration in Latin America (28%), which is reflected in 16 publications where this type of collaboration is found. On the other hand, Colombia and Chile have around 10% inter-country collaboration, even though they have a respectable number of publications, which reveals a total of 29 and 37 works with the presence of inter-country collaboration, respectively.
Chile as a case study

Even though at the country level a low rate of cooperation between Latin American nations was detected, this does not mean that they do not have other sources of collaboration. Actually, it seems that countries prefer to collaborate “within-country,” despite the fact that each country can collaborate with other nations outside the region. Taking this into account, the following analysis considers the case of Chile, based on its respectable inter-country collaboration.

For the analysis at the Chilean university and individual level, 338 articles were retrieved from Web of Science. The main objective of the search was to find records in which Chile appears in the addresses field, also finding records of publications in which the term Education appears in the Web of Science Categories field within a record, specifically including all records in which the term Education & Educational Research or Education, Special or Psychology, Educational appears in the Web of Science (WoS) categories field from the search.

Chilean articles by language and number of authors

According to the described search, the oldest article was written in 1941. More than twenty years later, the second article was published in 1967. Between 2000 and 2014, at least one article per year appears in WoS database, being this period the most prolific regarding published articles, with a clear increasing trend that can be observed in Figure 5-2. In addition, and taking into account the language of the available papers, it is significant to note that, overall, most papers were found in journals were the official language is English (74%). In second place are articles in Spanish (24%), and then papers in Portuguese (1%). Figure 5-2 shows the evolution in the production of articles between 2000 and 2014 for these three languages and overall.
Regarding the average number of authors in the mentioned span of time, there was never more than four authors, except for the year 2003, where the average was 8. This could be considered an outlier, mainly because that year just two articles were written, and one of them was co-authored by twelve scholars. Thus, the most common collaboration types are notably two-authors and three-authors per article, which can be observed in Figure 5-3.

Figure 5-2. Distribution of articles between 2000-2014.

Figure 5-3. Average number of authors per paper in 2000-2014.
It is relevant to mention that, in general, 91 articles were written by just one author. This means that collaboration (i.e., two or more authors per paper) has been found in 247 articles. This represents 73% of the total analyzed articles. Interestingly, a high percentage of them involved articles with two authors (26%), followed by three and four authors (19.8% and 13.6%, respectively). There are five articles that were co-authored by ten or more authors (one of them by 32 authors). These latter works could be considered extreme cases, nevertheless they show the willingness to include all the efforts involved in a published paper. Table 5-1 summarizes the number of articles and number of author in each one of them.

Table 5-1. Total published articles based on number of authors per article.

<table>
<thead>
<tr>
<th>Number of Authors</th>
<th>Number of articles</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>91</td>
<td>26.9%</td>
</tr>
<tr>
<td>2</td>
<td>88</td>
<td>26.0%</td>
</tr>
<tr>
<td>3</td>
<td>67</td>
<td>19.8%</td>
</tr>
<tr>
<td>4</td>
<td>46</td>
<td>13.6%</td>
</tr>
<tr>
<td>5</td>
<td>14</td>
<td>4.1%</td>
</tr>
<tr>
<td>6</td>
<td>15</td>
<td>4.5%</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>1.2%</td>
</tr>
<tr>
<td>8</td>
<td>6</td>
<td>1.8%</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>0.6%</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>0.3%</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>0.6%</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>0.3%</td>
</tr>
<tr>
<td>32</td>
<td>1</td>
<td>0.3%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>338</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

National and international collaboration for the Chilean case

It is interesting to note that within the 91 articles that were not co-authored, 6 of them were developed in international institutions, but just one of them included an author from a foreign institution who narrates her experience as an American visiting professor in a Chilean university. In the remaining five articles, the authors have a double-affiliation, i.e., both in a Chilean and in a foreign institution from either Argentina, Mexico, Uruguay, Germany, or the USA. The rest of the not co-authored articles were written by authors affiliated to a Chilean organization.
More remarkable is that 125 of the 247 co-authored articles included an international collaboration (51%) with countries from South, Central and North America, Europe, Asia, Oceania, and Africa. The rest of the papers were written through an inter-institutional Chilean collaboration. The patterns regarding the number of authors for both cases are presented in Table 5-2.

Table 5-2. Articles written based on number of authors per article including national or international collaboration.

<table>
<thead>
<tr>
<th>Number of Authors</th>
<th>Papers with international collaboration</th>
<th>Papers with just national collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of articles</td>
<td>%</td>
</tr>
<tr>
<td>2</td>
<td>43</td>
<td>34.4%</td>
</tr>
<tr>
<td>3</td>
<td>33</td>
<td>26.4%</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
<td>19.2%</td>
</tr>
<tr>
<td>5</td>
<td>9</td>
<td>7.2%</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>4.8%</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>1.6%</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>2.4%</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>1.6%</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>12</td>
<td>1</td>
<td>0.8%</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>0.8%</td>
</tr>
<tr>
<td>32</td>
<td>1</td>
<td>0.8%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>125</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>

When one contrasts the national and international collaboration of articles that involve Chile, the number of authors per paper is very similar, since the international dimension is an essential activity among scholars and universities. Thus, international co-authored papers are commonly used as a measure to obtain a comprehensive picture of the internationalization of research. In this regard, Appendix A indicates the countries with which Chile has collaborated in the educational field.

According to Appendix A, Chile has the largest collaboration in the educational field with the United States and Spain, followed by England. Interestingly, 17 of the 33 countries listed in Appendix A are located in Europe. This fact could explain the high percentage of articles written in English.
Journal collaborative distribution

In order to analyze the collaborative distribution of the articles, it is relevant to identify the journals with high rates of published papers based on the research sample. Thus, a total of 119 journals have published at least one of the analyzed articles. The most relevant of them are shown in Figure 5-4, based on their Web of Science categories.

![Figure 5-4. Distribution of papers among type of journals.](image)

It is important to recall that the general collaboration for Chile, either with national or international actors, is around 73%, which could be considered high. Taking into account the area or field of study where each paper was published, it is possible to note that the collaboration across fields (Figure 5-4) is always over 50%. The areas with more than 5 published papers that have the highest collaborative rates are the following: Special Education (100%), Computer Science (100%), and Educational Psychology (82.3%). Other fields with lower amount of total papers, such as Social Sciences (4) and Psychiatry (3) also present 100% of collaboration. Areas of study with less than 3 articles published are Information & Library Science, Law, Environmental Studies, Geography, Management, Urban Studies, Anthropology, and Philosophy. The latter six fields include just one paper, and the latter two are the only field that do not have collaborative papers.
Inter-institutional collaboration

The inter-institutional collaboration among Chilean organizations that publish on educational topics is fairly high. In fact, 70% of the analyzed papers involve two or more different Chilean institutions. Figure 5-5 shows the number of papers where each organization appears, along with their collaborative efforts with other institutions. In this figure, institutions with two or more total published papers are shown. A description of the acronyms and type of institution can be found in Appendix B.

Figure 5-5. Number of papers per institution.

A total of 45 institutions published at least one paper. Actually, eight of them published only one paper. According to Figure 5-5, the higher education institutions that are leading both total number of papers and collaborative efforts are the Pontifical Catholic University (PUC) and the University of Chile (UCH). Both institutions are participating in around 44% of the total published works (29.9% and 14.5%, respectively), and they also are contributing to 42.3% of the total inter-institutional collaborations (24.4% and 17.9%, respectively). Other institutions have much lower rates: between 0.2% and 7.9% in the mentioned indicators. In addition, although most organizations in Figure 5-5 are universities, one is an educational research center (PIIE),
another is the Ministry of Education (MINEDUC), a third is a public institution that promotes the stability and efficacy of the Chilean financial system (BANCOCENTRAL), and last but not least is the National Council of Television (CNTV).

Furthermore, the general inter-institutional collaboration is around 30%. In this regard, it is important to underline that PUC and UCH have by themselves higher rates of inter-institutional collaboration (24.5% and 37.3%, respectively). Most institutions have rates equal to or greater than 20%, except for four institutions: UFRO (13.3%), UCTEMUCO, UTAL, and UV (16.7% each).

Even though the general inter-institutional collaboration can be considered appropriate for the Chilean reality, this does not imply that the intra-institutional collaboration is totally absent (i.e., collaboration just within a specific organization). In fact, within a specific inter-institutional collaboration, the same institution may appear more than one time, indicating that, for instance, two or more researchers from the same university may contribute to several educational papers. Even more, 13 of the 45 analyzed organizations just publish with themselves: MINEDUC (5 papers), UAP, UCHBRIT, UTAR, UTEM (2 papers), and eight other institutions have just published one paper.

Taking into account this description at the country and university level, it is essential to analyze the collaboration at the scholar level.

Collaboration at the scholar level

Taking into account that in each analyzed article at least one author was living in Chile, it was possible to detect a total of 709 authors participating in the Chilean network at the scholar level between 1941 and 2014. Among them, 444 authors declared an address in Chile (62.6%) and 265 listed a place abroad (37.4%), which is considered as an international collaboration.

Given the span of time between 1941 and 2014 (73 years), it is important to analyze the evolution that has occurred in this network. Because I want to put an emphasis on the period between 2000-2014, I have divided the analysis between the span of time before 2000 and since 2000.

In general, most authors just appeared in one article (575 authors; 81.1% of the total). 53 authors wrote articles alone. Actually, 47 of them wrote just 1 article alone, one wrote 6 articles without collaboration, two wrote 4 papers in this way, one wrote 3, and two scholars wrote 2. This means that 7.5% of the 709 authors are not connected to the network in either analyzed periods of time. The quantity of authors by number of appearances is showed in Table 5-3.
Table 5-3. Number of authors based on number of appearances before and since 2000.

<table>
<thead>
<tr>
<th>Number of appearances</th>
<th>Before 2000</th>
<th>Since 2000</th>
<th>Total</th>
<th>Authors in both periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>77</td>
<td>506</td>
<td>583</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>84</td>
<td>88</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>23</td>
<td>23</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>13</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>38</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>83</strong></td>
<td><strong>635</strong></td>
<td><strong>718</strong></td>
<td><strong>9</strong></td>
</tr>
</tbody>
</table>

From the above table, it is important to highlight that just 9 authors appear in both analyzed periods of time (last column of the table) and all work for Chilean institutions. In this regard, it would be interesting to analyze the role of these scholars in the evolution of the network. It is interesting to note that most scholars that published papers between 2000 and 2014 are “new” actors in the network (626 scholars in total). On the contrary, 74 authors that published papers between 1941 and 1999 apparently stopped writing articles after 1999. According to Barnett and Fink (2008), the age distribution of early career and retiring scholars provide a good explanation for these patterns. In addition, these authors found that the diffusion of the Internet and the aging of faculty members appeared to be positively correlated.

Unfortunately, the dataset does not contain information about the seniority, years of experience or academic position of the authors, among other variables. Thus, it is difficult to determine and analyze the characteristics of the scholars in the network that might offer some further explanation for their actions in the network. However, as previously mentioned, there is information about the addresses/locations of the scholars. Thus, it is possible to classify the number of appearances by authors according to their national or international locations. This distribution appears in Table 5-4, recalling that the 9 authors who appear in both periods are located in national organizations. It is important to highlight that, henceforth, “national” and “international” refer to the author’s institutional affiliation with any institution located in Chile classified as being “national” and any other institution outside of Chile being classified as “international” location.
Table 5-4. Amount of authors based on number of appearances and location before and since 2000.

<table>
<thead>
<tr>
<th>Number of appearances</th>
<th>Before 2000</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>National</td>
<td>International</td>
<td>National</td>
<td>International</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>51</td>
<td>26</td>
<td>291</td>
<td>215</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>1</td>
<td>64</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>21</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>1</td>
<td>13</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td><strong>55</strong></td>
<td><strong>28</strong></td>
<td><strong>398</strong></td>
<td><strong>237</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

At this point it is relevant to mention that between 1941 and 1999, 9 authors with an international address published their papers as single authors and 19 out of 28 coauthored papers. On the other hand, between 2000 and 2014, only 3 international authors wrote their papers as single authors while 234 out of 237 coauthored papers. In other words, there was a significant increase in collaboration at the international level when the analyzed periods of time are compared.

It is important to recall that for this analysis a total of 338 articles were retrieved from the Web of Science database. 66 of them were published before 2000 and 272 since 2000. Thus, the ratio of authors/articles for the first period is 1.26 (83/66) and 2.33 (635/272) for the second period. Accordingly, one would expect more collaboration since 2000. Nevertheless, it is relevant to know the distribution of articles taking into account the number of authors for each analyzed period of time. This is showed in Table 5-5.
Table 5-5. Total published articles based on number of authors per article before and since 2000.

<table>
<thead>
<tr>
<th>Number of Authors</th>
<th>Before 2000</th>
<th>Since 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of articles</td>
<td>%</td>
</tr>
<tr>
<td>1</td>
<td>46</td>
<td>69.7%</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>15.2%</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>6.0%</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>7.6%</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>1.5%</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>12</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>14</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>32</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>66</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

As one can note, before 2000, almost 70% of the articles were written by just one author. In fact, 35 authors published their papers as single authors between 1941 and 1999 (26 of them with a national location). In contrast, since 2000, 83.5% of the published articles were co-authored by 2 or more authors. Actually, only 23 authors were publishing alone between 2000 and 2014 (20 of them declared a national location). In other words, there seems to be an intense collaboration since 2000, which in turn may be a factor in the patterns of leadership within the analyzed network.

Regarding each specific author, the 709 scholars detected in the analysis were ordered alphabetically and assigned to the same order that a Microsoft Excel sheet uses (i.e., A, B, C, …, Z, AA, AB, …, AZ, BA, BB,…, BZ, …, ZA, ZB, …, ZZ, AAA, AAB, and so on). The number of appearances of each author in either analyzed period of time is shown in Appendix C.

The authors who appear in both periods are AV, CU, IB, NV, QP, UF, WP, YR, and YS. Their number of papers for both periods, and how many of them were written alone, are shown in Table 5-6.
Table 5-6. Number of papers for authors that appear before and since 2000.

<table>
<thead>
<tr>
<th>Author</th>
<th>Before 2000</th>
<th>Since 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total articles</td>
<td>How many single-authored</td>
</tr>
<tr>
<td>AV</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CU</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>IB</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>NV</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>QP</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>UF</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>WP</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>YR</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>YS</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

The patterns of collaboration among these authors is certainly different. On one extreme of the collaborative spectrum, author CU wrote single-authored articles in both spans of time (in total, 4 out of 4 papers written alone). Author IB just wrote one article before 2000, but this was coauthored. However, since 2000 the same author has published as single author (in total, 2 out of 3 papers written alone). On the contrary, authors AV and NV did not collaborate before 2000, but then they coauthored most of their articles (in total, 1 out of 4 and 3 out of 5 papers written alone, respectively). On the other extreme, author QP, UF, WP, YR and YS coauthored all their papers, and the first three of them incremented their collaboration since 2000. The case of QP is particularly interesting, mainly because this author wrote only one coauthored article before 2000, and since 2000 QP coauthored 38 articles.

In sum, it seems that the patterns of coauthorship that involves Chilean scholars has undergone a significant evolution, probably influenced by an increasing amount of early career scholars since 2000, but also mainly by a preference among researchers to collaborate with others colleagues. This is actually reflected by the fact that, since 2000, there was a strong reduction of papers with just one author, as can be seen when this percentage is contrasted with the period before 2000 (69.7% and 16.5%, respectively). In addition, there was is a slight increase of the “internationalization” of papers. In fact, the presence of international authors (i.e., with an address outside of Chile) increased from 33.7% to 37.3%, when the span of times before and since 2000 are contrasted (28 out of 83, and 237 out of 635, respectively). This internationalization has also been considerably incremented in collaborative terms. Actually, before 2000, 67.9% of the international authors coauthored papers, and since 2000, 98.3% of the scholars located abroad...
coauthored at least one article. Thus, collaboration among scholars appears to be an important trend for the analyzed context, even at the international level, and it seems likely that these tendencies have been influencing the leadership patterns in the network of researchers for the Chilean setting, the topic to be analyzed in the next section.

II. Leadership and the Development of Cooperation

In the previous section, significant rates of Chilean collaboration were found at the country, institutional and scholar levels. However, it seems that every actor in each network plays different roles in order to facilitate and lead collaborative efforts. Thus, the analysis of collaboration among different types of actors linked to educational investigation allow to detect the rise of leadership. That is because collaboration influences the research performance and dissemination, and also it is frequently considered a function of the internal group dynamics of different areas of study as well as scientific policy plans and strategies (Luukkonen et al., 1993).

Over 30 years ago, Cronin (1982) argued that, in general, countries, colleges, and scholars are members of a worldwide community that usually work together to understand several issues. Thus, the amplitude of humanities and social sciences, along with the interdependence of researchers across several cultural, social and geographical backgrounds offer a trustworthy setting to study the development, structure, and configurations of knowledge in the educational field. In this regard, Social Network Analysis can provide useful information and indicators about collaborative patterns and leadership within multi-authored papers in education.

Leadership at the country level

At the country level, a map of the collaborative connections that considers educational research among Latin American nations is showed in Figure 5-6. In order to provide a meaningful analysis, countries are arranged taking into account their actual geographic location in the continent. Edge weights represent the number of multi-authored publications among countries. In addition, node sizes are based on the degree centrality of each country, in order to understand the extent to which a node connects to all other nodes in a social network (Wasserman & Faust, 1994).
At the network level, this collaborative arrangement of countries has a density of 0.193. This means that 19.3% of the potential connections occur in this network. At the node (country) level, Table 5-7 shows the most relevant SNA indicators that involve leadership roles among these countries, such as degree, betweenness, and closeness centralities, along with their normalized versions (in percentage), taking into account that Luukkonen and her colleagues (1993) concluded that, in an analysis of collaborative links, it is essential to use both absolute and relative measures. The latter normalize differences taking into account the total number of connected countries within the network. Countries were ordered by the largest to smallest degree centrality.
### Table 5-7. Social network centralities by country.

<table>
<thead>
<tr>
<th>Country</th>
<th>Degree</th>
<th>nDegree</th>
<th>Betweenness</th>
<th>nBetweenness</th>
<th>Farness</th>
<th>nCloseness</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHILE</td>
<td>11</td>
<td>61.10%</td>
<td>30.07</td>
<td>19.65%</td>
<td>15</td>
<td>86.70%</td>
</tr>
<tr>
<td>ARGENTINA</td>
<td>8</td>
<td>44.40%</td>
<td>13.12</td>
<td>8.60%</td>
<td>18</td>
<td>72.20%</td>
</tr>
<tr>
<td>MEXICO</td>
<td>8</td>
<td>44.40%</td>
<td>14.32</td>
<td>9.40%</td>
<td>18</td>
<td>72.20%</td>
</tr>
<tr>
<td>BRAZIL</td>
<td>7</td>
<td>38.90%</td>
<td>3.62</td>
<td>2.40%</td>
<td>19</td>
<td>68.40%</td>
</tr>
<tr>
<td>COLOMBIA</td>
<td>7</td>
<td>38.90%</td>
<td>2.40</td>
<td>1.60%</td>
<td>19</td>
<td>68.40%</td>
</tr>
<tr>
<td>PERU</td>
<td>5</td>
<td>27.80%</td>
<td>0.20</td>
<td>0.13%</td>
<td>22</td>
<td>59.10%</td>
</tr>
<tr>
<td>VENEZUELA</td>
<td>5</td>
<td>27.80%</td>
<td>0.37</td>
<td>0.24%</td>
<td>21</td>
<td>61.90%</td>
</tr>
<tr>
<td>CUBA</td>
<td>3</td>
<td>16.70%</td>
<td>0.00</td>
<td>0.00%</td>
<td>24</td>
<td>54.20%</td>
</tr>
<tr>
<td>ECUADOR</td>
<td>3</td>
<td>16.70%</td>
<td>0.00</td>
<td>0.00%</td>
<td>24</td>
<td>54.20%</td>
</tr>
<tr>
<td>URUGUAY</td>
<td>3</td>
<td>16.70%</td>
<td>0.00</td>
<td>0.00%</td>
<td>24</td>
<td>54.20%</td>
</tr>
<tr>
<td>GUATEMALA</td>
<td>2</td>
<td>11.10%</td>
<td>0.50</td>
<td>0.33%</td>
<td>28</td>
<td>46.40%</td>
</tr>
<tr>
<td>PANAMA</td>
<td>2</td>
<td>11.10%</td>
<td>1.42</td>
<td>0.93%</td>
<td>25</td>
<td>52.00%</td>
</tr>
<tr>
<td>BOLIVIA</td>
<td>1</td>
<td>5.60%</td>
<td>0.00</td>
<td>0.00%</td>
<td>27</td>
<td>48.10%</td>
</tr>
<tr>
<td>DOM. REP.</td>
<td>1</td>
<td>5.60%</td>
<td>0.00</td>
<td>0.00%</td>
<td>30</td>
<td>43.30%</td>
</tr>
<tr>
<td>COSTA RICA</td>
<td>0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.00%</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>EL SALVADOR</td>
<td>0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.00%</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>HONDURAS</td>
<td>0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.00%</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>NICARAGUA</td>
<td>0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.00%</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>PARAGUAY</td>
<td>0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.00%</td>
<td>0</td>
<td>-</td>
</tr>
</tbody>
</table>

Within this network significant findings can be detected. First of all, Chile has the highest normalized degree, betweenness and closeness centralities. This means that Chile has the capacity to lead the network despite the fact that it is a tiny country in terms of population, and also considering its isolation within the region, in geographic terms. In fact, its high degree centrality indicates that Chile has the highest number of direct connections among the countries of the network. In addition, its high betweenness centrality suggests that Chile has a strategic position on paths within the network, mainly because it has several non-redundant paths to other countries. Finally, its high closeness centrality implies that Chile can interact quickly with other countries in the network.

Furthermore, the largest countries by population within the region, such as Argentina, Mexico, Brazil and Colombia, are also leading the network. The role of Brazil is remarkable, taking into account that in this network is the only nation where the official language is Portuguese instead of Spanish. More concerning is the situation of Costa Rica, El Salvador, Honduras, Nicaragua and Paraguay. These countries are totally disconnected from the network, but in general, this network has the potential to improve the connections among its actors.
Leadership at the institutional level

As it was mentioned in the methodology section of this study, cluster analysis is appropriate for large networks. In this case, collaborative efforts at the institutional and scholar levels offer the opportunity to lead this prime examination. The clusters were identified by calculating Wakita-Tsurumi indicator (Wakita and Tsurumi, 2007). These metrics identify "neighborhoods" of cooperation as defined by cooperation patterns and frequencies that result in a high density within a subset of nodes.

Figure 5-7 shows the institutional collaboration among Chilean higher education institutions, and Appendix B describes each institution involved. Each color represents a specific cluster (7 in total), and 13 unconnected institutions are represented as black dots around the entire network.

The detected collaborative efforts at the institutional level are actually connecting 32 institutions. If one just takes into account these actors, the density of the network would be 0.1028 (10.28%). However, because 13 institutions are publishing papers but are not connected with the entire network, the density of this network is actually 0.0515 (5.15%). In other words, only 102 collaborative efforts between two or more institutions were actually made, among a
potential total of 1,980 connections, if every institution was completely connected with the others. Table 5-8 shows the social network indicators (centralities) for each institution of the previous network, which were ordered by the largest to smallest degree centrality.

Table 5-8. Social network centralities by institution.

<table>
<thead>
<tr>
<th>Institution</th>
<th>Degree</th>
<th>nDegree</th>
<th>Betweenness</th>
<th>nBetweenness</th>
<th>Farness</th>
<th>nCloseness</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUC</td>
<td>17</td>
<td>38.60%</td>
<td>241.07</td>
<td>25.48%</td>
<td>52</td>
<td>59.62%</td>
</tr>
<tr>
<td>UCH</td>
<td>13</td>
<td>29.50%</td>
<td>178.10</td>
<td>18.83%</td>
<td>56</td>
<td>55.36%</td>
</tr>
<tr>
<td>PUCV</td>
<td>8</td>
<td>18.20%</td>
<td>99.60</td>
<td>10.53%</td>
<td>59</td>
<td>52.54%</td>
</tr>
<tr>
<td>USACH</td>
<td>6</td>
<td>13.60%</td>
<td>40.77</td>
<td>4.31%</td>
<td>62</td>
<td>50.00%</td>
</tr>
<tr>
<td>UDP</td>
<td>5</td>
<td>11.40%</td>
<td>31.67</td>
<td>3.35%</td>
<td>65</td>
<td>47.69%</td>
</tr>
<tr>
<td>UCSC</td>
<td>4</td>
<td>9.10%</td>
<td>18.80</td>
<td>1.99%</td>
<td>72</td>
<td>43.06%</td>
</tr>
<tr>
<td>UDEC</td>
<td>4</td>
<td>9.10%</td>
<td>86.00</td>
<td>9.01%</td>
<td>76</td>
<td>40.79%</td>
</tr>
<tr>
<td>UCENTRAL</td>
<td>3</td>
<td>6.80%</td>
<td>0.00</td>
<td>0.00%</td>
<td>76</td>
<td>40.79%</td>
</tr>
<tr>
<td>UCN</td>
<td>3</td>
<td>6.80%</td>
<td>0.00</td>
<td>0.00%</td>
<td>68</td>
<td>45.59%</td>
</tr>
<tr>
<td>UST</td>
<td>3</td>
<td>6.80%</td>
<td>0.00</td>
<td>0.00%</td>
<td>76</td>
<td>40.79%</td>
</tr>
<tr>
<td>UTFSM</td>
<td>3</td>
<td>6.80%</td>
<td>0.00</td>
<td>0.00%</td>
<td>70</td>
<td>44.29%</td>
</tr>
<tr>
<td>PIIE</td>
<td>3</td>
<td>6.80%</td>
<td>0.00</td>
<td>0.00%</td>
<td>73</td>
<td>42.47%</td>
</tr>
<tr>
<td>INACAP</td>
<td>2</td>
<td>4.50%</td>
<td>0.00</td>
<td>0.00%</td>
<td>77</td>
<td>40.26%</td>
</tr>
<tr>
<td>UANDES</td>
<td>2</td>
<td>4.50%</td>
<td>30.00</td>
<td>3.17%</td>
<td>80</td>
<td>38.75%</td>
</tr>
<tr>
<td>UAUSTRAL</td>
<td>2</td>
<td>4.50%</td>
<td>30.00</td>
<td>3.17%</td>
<td>130</td>
<td>23.85%</td>
</tr>
<tr>
<td>UCMAULE</td>
<td>2</td>
<td>4.50%</td>
<td>30.00</td>
<td>3.17%</td>
<td>84</td>
<td>36.90%</td>
</tr>
<tr>
<td>UDD</td>
<td>2</td>
<td>4.50%</td>
<td>0.00</td>
<td>0.00%</td>
<td>81</td>
<td>38.27%</td>
</tr>
<tr>
<td>UFRO</td>
<td>2</td>
<td>4.50%</td>
<td>0.00</td>
<td>0.00%</td>
<td>81</td>
<td>38.27%</td>
</tr>
<tr>
<td>USS</td>
<td>2</td>
<td>4.50%</td>
<td>58.00</td>
<td>6.13%</td>
<td>102</td>
<td>30.39%</td>
</tr>
<tr>
<td>BANCOCENTRAL</td>
<td>2</td>
<td>4.50%</td>
<td>0.00</td>
<td>0.00%</td>
<td>75</td>
<td>41.33%</td>
</tr>
<tr>
<td>UAH</td>
<td>1</td>
<td>2.30%</td>
<td>0.00</td>
<td>0.00%</td>
<td>82</td>
<td>37.80%</td>
</tr>
<tr>
<td>UAHC</td>
<td>1</td>
<td>2.30%</td>
<td>0.00</td>
<td>0.00%</td>
<td>95</td>
<td>32.63%</td>
</tr>
<tr>
<td>UAI</td>
<td>1</td>
<td>2.30%</td>
<td>0.00</td>
<td>0.00%</td>
<td>86</td>
<td>36.05%</td>
</tr>
<tr>
<td>UBB</td>
<td>1</td>
<td>2.30%</td>
<td>0.00</td>
<td>0.00%</td>
<td>114</td>
<td>27.19%</td>
</tr>
<tr>
<td>UCTEMUOCO</td>
<td>1</td>
<td>2.30%</td>
<td>0.00</td>
<td>0.00%</td>
<td>82</td>
<td>37.80%</td>
</tr>
<tr>
<td>ULASERENA</td>
<td>1</td>
<td>2.30%</td>
<td>0.00</td>
<td>0.00%</td>
<td>89</td>
<td>34.83%</td>
</tr>
<tr>
<td>UMCE</td>
<td>1</td>
<td>2.30%</td>
<td>0.00</td>
<td>0.00%</td>
<td>89</td>
<td>34.83%</td>
</tr>
<tr>
<td>UNAB</td>
<td>1</td>
<td>2.30%</td>
<td>0.00</td>
<td>0.00%</td>
<td>86</td>
<td>36.05%</td>
</tr>
<tr>
<td>UPLA</td>
<td>1</td>
<td>2.30%</td>
<td>0.00</td>
<td>0.00%</td>
<td>160</td>
<td>19.38%</td>
</tr>
<tr>
<td>UTAL</td>
<td>1</td>
<td>2.30%</td>
<td>0.00</td>
<td>0.00%</td>
<td>110</td>
<td>28.18%</td>
</tr>
<tr>
<td>UV</td>
<td>1</td>
<td>2.30%</td>
<td>0.00</td>
<td>0.00%</td>
<td>86</td>
<td>36.05%</td>
</tr>
<tr>
<td>CNTV</td>
<td>1</td>
<td>2.30%</td>
<td>0.00</td>
<td>0.00%</td>
<td>86</td>
<td>36.05%</td>
</tr>
<tr>
<td>UANTOF</td>
<td>0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.00%</td>
<td>0</td>
<td>-</td>
</tr>
</tbody>
</table>
According to the previous indicators and sociogram of Figure 5-7, there are two institutions that are leading the network at the institutional level: PUC and UCH. They have a total of 17 and 13 direct connections, respectively. In turn, they are easily reachable—which is reflected in their high closeness centralities (over 50%)—and they can also be used as bridgers by other organizations to get several institutions in this network, taking into account that PUC and UCH have the highest betweenness centralities among the analyzed actors (25.48% and 18.83%, respectively). Interestingly, there is a strong collaboration between PUC and UCH. Actually, this is the most productive relationship in terms of co-authorship of articles within the entire network.

On a lesser scale, other higher education institutions that are executing leadership in this collaborative network are PUCV and USACH. The four mentioned universities are also leading their own clusters within the network. In this regard, three other clusters or subgroups within the network seem to be led by UDP, UDEC, and UANDES.

**Leadership at the scholar level**

Several researchers (Borgatti & Foster, 2003; Gray, 1989; Mandell & Steelman, 2003; Muijs, Ainscow, Chapman & West, 2011) have argued that people are usually apt to trust and be influenced by others with whom they share common ground—such as interests, decisions, perspectives or background—, which in turn increases their willingness to be involved in continued interactive communication, collaboration and teamwork. This process can also move in the other direction (e.g., collaboration based on a common goal, etc.) (Burke & Barron, 2014; Kaats & Opheij, 2014). These arrangements of people have been connected with leadership roles and the power of networking (Bacon, 2011; Gobillot, 2009; Grant, 2013).
This is especially suitable for the academic world, where there are common interests to increase the knowledge of a field, such as education, mainly in the form of articles published in journals across the world, usually done in collaboration with other colleagues found in both national and international contexts. In this regard, an analysis at the scholar level of the collaborative efforts through coauthored papers can illuminate evidence about the patterns of collaboration and leadership among scholars within a specific context, such as the Chilean educational research.

As previously mentioned, degree centrality is used to measure who are or become the most important central actors in a network, which still will be represented through the use of sociograms at the scholar level. Nevertheless, because in this case the system at the scholar level involves an important number of scholars, and the degree centralities (total amount of connections of each author) can be strongly influenced either by the number of authors per paper or the number of papers per se (e.g., an author with just one paper coauthored with 4 authors will have the same degree centrality as another author with 4 papers coauthored with 4 different colleagues), it seems reasonable to focus the analysis on the betweenness centralities, in order to identify the nodes that are acting as bridgers or gatekeepers in the network, i.e., who are well-embedded in a network, connecting themselves and other individuals at large, in terms of the fraction of shortest paths that pass through them, quantifying the importance of sociogram actors (Kourtellis, Morales & Bonchi, 2015; Hoppe, & Reinelt, 2010; Zhu, Watts & Chen, 2010). These ideas are supported in the notions of streams of information promoted by opinion leaders, capturing their potential for communication control among actors (Brandes, Borgatti & Freeman, 2016; Rychen & Zimmermann, 2008). In order to detect leadership roles, degree, betweenness and closeness centralities should be analyzed all together and overall in their respective tables, but these will be ordered from the largest to smallest betweenness centralities.

In addition, a cluster analysis makes perfect sense at the scholar level, due to the large number of scholars in the network who can be grouped in several sub-networks. As mentioned in the analysis at the institutional level, cluster analysis is an important method for analyzing social networks, which aims to reveal the sub-structure of a system, indicating the sub-groups of nodes that have a more immediate, closer and frequent relationship with other nodes in the same sub-groups (Li & Ding, 2013).
Leadership roles before 2000

Taking into account the previous paragraphs, Figure 5-8 shows the coauthorship network before 2000. The size of each node is based on its particular degree centrality. At the same time, the color of the nodes represents belonging to a specific cluster. In this regard, nodes in black represent scholars unconnected with other colleagues, which means that the latter have not been collaborating with other researchers. In addition, the width of the edges represents the intensity of the collaboration.

Figure 5-8. Scholars’ collaborative network for the Chilean context before 2000.

At the network level, prior to 2000, scholars’ collaboration through coauthorship of articles has a density of 0.019. This means that only 1.9% of the potential connections occur within this network. In addition, from the previous figure it is possible to note several issues at the node (scholar) level. Firstly, there is a significant amount of scholars that are peripheral in the
network. A total of 35 authors are absolutely unconnected with other colleagues, since they did not co-author any papers. This fact is actually affecting the low density of the network itself. Although most of them wrote just one article alone, authors BO and VN wrote single-authored articles twice. Additionally, 10 more authors (B, HX, GU, LC, UM, CQ, KG, WM, YU, and YS) only collaborated once with just one other colleague, becoming peripheral within the network.

Second, there are 3 clusters composed of 3 scholars, and 4 clusters contain 4 researchers, one has 6 academics and one has 7 scholars. Remarkably, there are not any links between these clusters, which probably means that they are completely self-determining their actions.

In this case, the former three structures of clusters involve just one article. This means that three articles were written by 3 authors, four by 4 scholars, and one by 6 authors. Only the cluster in dark blue, which contained 7 authors, presents an interaction that involves more than one article. In this regard, author VK was leading the network, creating connections with other scholars and producing 7 co-authored articles (4 with HH, 1 with OT, 1 with OT and ZI, and 1 with MX, DR and IR). It is important to mention that, in addition, author VK wrote 8 articles alone, developing a total of 15 articles.

These patterns can also be complemented and corroborated by the centralities indicators of each author. Table 5-9 shows these values just for the authors with any connections within the network. All of the values for unconnected scholars are equal to zero. For previously mentioned reasons, scholars were ordered by the largest to smallest betweenness centrality.

Table 5-9. Social network centralities by author before 2000.

<table>
<thead>
<tr>
<th>Scholar</th>
<th>Degree</th>
<th>nDegree</th>
<th>Betweenness</th>
<th>nBetweenness</th>
<th>Farness</th>
<th>nCloseness</th>
</tr>
</thead>
<tbody>
<tr>
<td>VK</td>
<td>6</td>
<td>7.30%</td>
<td>11.00</td>
<td>0.33%</td>
<td>6</td>
<td>783.33%</td>
</tr>
<tr>
<td>HH</td>
<td>1</td>
<td>1.20%</td>
<td>0.00</td>
<td>0.00%</td>
<td>11</td>
<td>427.27%</td>
</tr>
<tr>
<td>OT</td>
<td>2</td>
<td>2.40%</td>
<td>0.00</td>
<td>0.00%</td>
<td>10</td>
<td>470.00%</td>
</tr>
<tr>
<td>ZI</td>
<td>2</td>
<td>2.40%</td>
<td>0.00</td>
<td>0.00%</td>
<td>10</td>
<td>470.00%</td>
</tr>
<tr>
<td>DR</td>
<td>3</td>
<td>3.70%</td>
<td>0.00</td>
<td>0.00%</td>
<td>9</td>
<td>522.22%</td>
</tr>
<tr>
<td>IR</td>
<td>3</td>
<td>3.70%</td>
<td>0.00</td>
<td>0.00%</td>
<td>9</td>
<td>522.22%</td>
</tr>
<tr>
<td>MX</td>
<td>3</td>
<td>3.70%</td>
<td>0.00</td>
<td>0.00%</td>
<td>9</td>
<td>522.22%</td>
</tr>
<tr>
<td>J</td>
<td>5</td>
<td>6.10%</td>
<td>0.00</td>
<td>0.00%</td>
<td>5</td>
<td>940.00%</td>
</tr>
<tr>
<td>MO</td>
<td>5</td>
<td>6.10%</td>
<td>0.00</td>
<td>0.00%</td>
<td>5</td>
<td>940.00%</td>
</tr>
<tr>
<td>NR</td>
<td>5</td>
<td>6.10%</td>
<td>0.00</td>
<td>0.00%</td>
<td>5</td>
<td>940.00%</td>
</tr>
<tr>
<td>PD</td>
<td>5</td>
<td>6.10%</td>
<td>0.00</td>
<td>0.00%</td>
<td>5</td>
<td>940.00%</td>
</tr>
<tr>
<td>XE</td>
<td>5</td>
<td>6.10%</td>
<td>0.00</td>
<td>0.00%</td>
<td>5</td>
<td>940.00%</td>
</tr>
<tr>
<td>XG</td>
<td>5</td>
<td>6.10%</td>
<td>0.00</td>
<td>0.00%</td>
<td>5</td>
<td>940.00%</td>
</tr>
</tbody>
</table>
In this table, VK is the only node with a betweenness centrality other than zero, and also has the highest degree centrality, along with the lowest farness (i.e., the highest closeness within its own cluster), confirming the relevant role of this researcher within the analyzed network.
Interestingly, besides VK, no other nodes are acting as bridgers within the network. Actually, all the other scholars have betweenness centrality values equal to zero, which means that no scholar is connecting other researchers beyond his or her cluster. On the contrary, VK has the capacity to link several nodes and sub-structures within its cluster. For instance, VK may facilitate communication between the sub-cluster DR-IR-MX and the sub-cluster, between HH and the mentioned sub-structures, and so on.

Regarding the displayed normalized closeness values, these may be overinflated, mainly since they are taking into account all the connected nodes within network (48 in total). However, if these values were based on the number of nodes in each cluster for each scholar, closeness values would be equally high for clusters formed by 2, 3, 4 or 6 scholars, basically because in these cases the nodes are completely connected with each other. Thus, because every cluster is unconnected from the others, it seems to only make sense to analyze closeness centrality within the cluster formed by 7 scholars. In this case, VK would have a closeness equal to 100% (6 divided by 6), DR, IR and MX 66.7% (6 divided by 9), OT and ZI 60% (6 divided by 10), and HH 54.5% (6 divided 11). For this specific network, farness values can guide the role of each node, but only within their own clusters.

The international aspect of the collaboration in education at any level has been considered relevant because this gives more opportunities for connections in the current globalized and highly technology-driven age (O'Meara & Spittle, 2012; Sakamoto & Chapman, 2011). Accordingly, the previous sociogram can also be analyzed from this perspective. In this regard, Figure 5-9 shows the same authors from the previous network, but this time taking into account their locations. Black nodes represent Chilean locations and red nodes indicate international ones.
Interestingly, from the previous figure, more isolated scholars are located in Chile. In addition, clusters composed of 2, 3 or 4 authors are mostly formed just by scholars located in Chile. The only exceptions are the cluster formed by YR, GJ, and SV –where the latter are located outside Chile– and the clusters conformed by QA, KL, TM and AB, and KG with WN, where all the scholars are located abroad (QA and WN had a double affiliation with an international and national institutions). A noteworthy finding is that the cluster formed by 6 scholars has just one author located in Chile. Even more interesting, the biggest cluster, where VK is participating, is formed mostly by international scholars. Actually, VK is the only national researcher in this sub-network, probably taking advantage of its specific international connections for collaborative efforts.
Bringing together Figures 5-8, 5-9 and Table 5-9, it is possible to state that, prior to 2000, the Chilean network of scholars was highly unconnected. A significant number of scholars published their papers as single authors, and the researchers that were in some way connected with others apparently preferred to work within specific clusters. Smaller clusters were mostly formed by scholars located in Chile collaborating on just one article, but bigger groups were formed by researchers located abroad, where the biggest clusters were collaborating on more than one article. Finally, VK was the only scholar that played a leadership role. Checking its specific status, after coauthoring articles within this network, this Chilean scholar was eventually named Ministry of Education during the first democratic government after the Chilean dictatorship that ended in 1990.

Leadership roles since 2000

This study aims a special focus on the period between 2000-2014, since potential advancements of the network may represent the influence of specific factors of the 21st century at the global level, such as globalization, technological networking, and also the effects of specific democratic policies at the local level. Figure 5-10 shows the coauthored network since 2000. The size of each node represents degree centrality, and the width of the edges represents the amount of coauthored articles. Colors and shapes of the nodes represent different clusters (also, each group is labeled with a number, from G1 to G112), and black nodes represent unconnected researchers. In addition, because trying to identify each node in a graph with 635 nodes it is not visually rewarding, only scholars with a significant normalized betweenness centrality value (greater than 0.1%) were identified (15 in total), along with the 9 scholars who appeared in the network before 2000. Appendix D presents the scholars of each cluster, along with the researchers that wrote articles alone.
Figure 5-10. Scholars’ collaborative network for the Chilean context since 2000.

At the network level, since 2000, collaboration among researchers through coauthored articles has a density of 0.009. This means that only 0.9% of the potential connections were evidenced within this network. However, taking into account the density of the network in Figure 5-8 (1.9%) and the increase in the number of authors compared with the period before 2000 (from 83 to 635), it is possible to argue that, since 2000, the network has achieved a respectable density.

In addition, at the node (researcher) level, there seems to be a progress in terms of collaboration and leadership, when this period is contrasted with the span of time between 1941 and 1999. Regarding the isolated scholars, there are only 23 authors unconnected with other colleagues (35 authors were unconnected before 2000). Appendix D shows who did not coauthor articles since 2000. Most of them wrote just one single-authored article. The 5 exceptions were author CU (6 articles alone), JQ (4 papers alone), CU (3 papers alone), and HA and IB (2 articles
alone). One can realize that authors CU and IB were present in the network before 2000, and author CU was consistently writing alone in both analyzed periods.

On the other hand, a total of 112 different clusters were detected. Most scholars are grouped in clusters of 2 people (30 in total). Even though most of the two-author relationships involved just one article, the most collaborative link was between QF and UC in G104, co-authoring a total of 3 articles, followed by the pairs LW-MB in G96 and BN-KF in G92, who collaborated on 2 papers. Next were other researchers grouped in clusters of 3 scholars (30 in total), and the majority of these relationships included just one article, but two of them included 2 co-authored articles among 3 researchers, such as the trios of PW-XS-TJ in G66 and V-SG-KQ in G69.

In addition, 18 clusters revealed a sub-structure of 4 scholars, 11 involved 5 authors, and 12 more clusters comprised 6 or more scholars, which are detailed in Appendix D. The most remarkable clusters appear to be G51 and G52 (4 authors), G30 (5 authors), G8, G6, G4 and G3, mainly because they are connected to the bigger cluster within the network: G1 (composed by 80 scholars).

In contrast to the network before 2000, and although most clusters since 2000 are disconnected from other sub-networks, the scholars of the previously mentioned 7 clusters, besides to be connected to G1, have the chance to communicate and interact with other nodes from sub-structures of the network –this point is also especially true for scholars from G1–, which allowed the development of more elaborated leadership roles than that developed before 2000 by author VK.

In this regard, Table 5-10 shows the centralities indicators of the main researchers of the network since 2000. Scholars are ordered by largest to smallest betweenness centralities, taking into account researchers with a value in this centrality greater than 0.1%.

Table 5-10. Social network centralities by author since 2000.

<table>
<thead>
<tr>
<th>Scholar</th>
<th>Degree</th>
<th>nDegree</th>
<th>Betweenness</th>
<th>nBetweenness</th>
<th>Farness</th>
<th>nClosennes</th>
</tr>
</thead>
<tbody>
<tr>
<td>QP</td>
<td>106</td>
<td>16.70%</td>
<td>12044.500</td>
<td>6.002%</td>
<td>278</td>
<td>219.78%</td>
</tr>
<tr>
<td>NL</td>
<td>19</td>
<td>3.00%</td>
<td>3213.000</td>
<td>1.601%</td>
<td>383</td>
<td>159.53%</td>
</tr>
<tr>
<td>SD</td>
<td>12</td>
<td>1.90%</td>
<td>2034.333</td>
<td>1.014%</td>
<td>405</td>
<td>150.86%</td>
</tr>
<tr>
<td>PP</td>
<td>14</td>
<td>2.20%</td>
<td>1625.500</td>
<td>0.810%</td>
<td>670</td>
<td>91.19%</td>
</tr>
<tr>
<td>KU</td>
<td>15</td>
<td>2.40%</td>
<td>1600.000</td>
<td>0.797%</td>
<td>415</td>
<td>147.23%</td>
</tr>
<tr>
<td>FJ</td>
<td>20</td>
<td>3.20%</td>
<td>1476.000</td>
<td>0.736%</td>
<td>395</td>
<td>154.68%</td>
</tr>
<tr>
<td>RV</td>
<td>10</td>
<td>1.60%</td>
<td>1221.500</td>
<td>0.609%</td>
<td>567</td>
<td>107.76%</td>
</tr>
</tbody>
</table>
In addition, Table 5-11 contrasts the centralities before and since 2000 for the 9 authors that appeared in both of these periods of time, in order to compare their role in both networks.

Table 5-11. Social network centralities by author before and since 2000.

<table>
<thead>
<tr>
<th>Period</th>
<th>Scholar</th>
<th>Degree</th>
<th>nDegree</th>
<th>Betweenness</th>
<th>nBetweenness</th>
<th>Farness</th>
<th>nCloseness</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000-2014</td>
<td>QP</td>
<td>106</td>
<td>16.70%</td>
<td>12044.500</td>
<td>6.002%</td>
<td>278</td>
<td>219.78%</td>
</tr>
<tr>
<td>1941-1999</td>
<td>QP</td>
<td>3</td>
<td>3.70%</td>
<td>0.00</td>
<td>0.00%</td>
<td>3</td>
<td>1566.67%</td>
</tr>
<tr>
<td>2000-2014</td>
<td>UF</td>
<td>14</td>
<td>2.20%</td>
<td>58.000</td>
<td>0.029%</td>
<td>401</td>
<td>152.37%</td>
</tr>
<tr>
<td>1941-1999</td>
<td>UF</td>
<td>3</td>
<td>3.70%</td>
<td>0.00</td>
<td>0.00%</td>
<td>3</td>
<td>1566.67%</td>
</tr>
<tr>
<td>2000-2014</td>
<td>WP</td>
<td>5</td>
<td>0.80%</td>
<td>14.000</td>
<td>0.007%</td>
<td>9</td>
<td>6788.89%</td>
</tr>
<tr>
<td>1941-1999</td>
<td>WP</td>
<td>3</td>
<td>3.70%</td>
<td>0.00</td>
<td>0.00%</td>
<td>3</td>
<td>1566.67%</td>
</tr>
<tr>
<td>2000-2014</td>
<td>AV</td>
<td>4</td>
<td>0.60%</td>
<td>5.000</td>
<td>0.002%</td>
<td>4</td>
<td>15275.00%</td>
</tr>
<tr>
<td>1941-1999</td>
<td>AV</td>
<td>0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.00%</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>2000-2014</td>
<td>YR</td>
<td>3</td>
<td>0.50%</td>
<td>0.000</td>
<td>0.00%</td>
<td>7</td>
<td>8728.57%</td>
</tr>
<tr>
<td>1941-1999</td>
<td>YR</td>
<td>2</td>
<td>2.40%</td>
<td>0.00</td>
<td>0.00%</td>
<td>2</td>
<td>2350.00%</td>
</tr>
<tr>
<td>2000-2014</td>
<td>NV</td>
<td>2</td>
<td>0.30%</td>
<td>0.000</td>
<td>0.00%</td>
<td>6</td>
<td>10183.33%</td>
</tr>
<tr>
<td>1941-1999</td>
<td>NV</td>
<td>0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.00%</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>2000-2014</td>
<td>YS</td>
<td>1</td>
<td>0.20%</td>
<td>0.000</td>
<td>0.00%</td>
<td>3</td>
<td>20366.67%</td>
</tr>
<tr>
<td>1941-1999</td>
<td>YS</td>
<td>1</td>
<td>1.20%</td>
<td>0.00</td>
<td>0.00%</td>
<td>1</td>
<td>4700.00%</td>
</tr>
<tr>
<td>2000-2014</td>
<td>IB</td>
<td>0</td>
<td>0.00%</td>
<td>0.000</td>
<td>0.00%</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>1941-1999</td>
<td>IB</td>
<td>3</td>
<td>3.70%</td>
<td>0.00</td>
<td>0.00%</td>
<td>3</td>
<td>1566.67%</td>
</tr>
<tr>
<td>2000-2014</td>
<td>CU</td>
<td>0</td>
<td>0.00%</td>
<td>0.000</td>
<td>0.00%</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>1941-1999</td>
<td>CU</td>
<td>0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.00%</td>
<td>0</td>
<td>-</td>
</tr>
</tbody>
</table>

First of all, regarding the displayed normalized closeness centralities, and similar to the situation before 2000 (Table 5-9), it is important to note that these may be overinflated, mainly since they are taking into account all the connected nodes within the network (635 in total). Again, if these values were based on the number of nodes in each cluster for each scholar,
closeness values would be equally high for the several cluster sizes within the network, because in these sub-structures the nodes are mostly connected with each other. Therefore, since clusters G1, G3, G4, G6, G8, G30, G51, and G52 are connected with each other, it seems to make sense to analyze closeness centrality of nodes from these clusters, which is actually the case, except for nodes CU and IB, who are unconnected within the network, and nodes AV, NV, WP, YR, and YS, who appear to work within their own sub-networks. In this case, because the sum of nodes from the 7 mentioned clusters is 148, QP would have a closeness equal to 52.9% (147 divided by 278), NL a value equal to 38.4% (147 divided by 383), SD a closeness of 36.3% (147 divided by 405), and PP a value equal to 54.5% (147 divided by 670), and so on. In a similar way to the network before 2000, farness values can guide the role of each node, but only within their own coauthorship sub-structures.

Thus, according to the previous tables, QP is by far the scholar with the highest betweenness centrality, and at the same time has the highest degree centrality, along with the lowest farness (i.e., the highest closeness within its own cluster). In general, most of the analyzed 24 researchers are acting as prevailing bridgers, connecting several clusters. As it was mentioned before, the exceptions are scholars CU and IB, who published their papers as single authors, and researchers AV, NV, WP, YR, and YS, who coauthored articles within their own collaborative clusters. Interestingly, a quick review reveals that AV’s cluster is based on 3 coauthored articles about school teachers; NV’s substructure is supported by 3 collaborative articles about history and education. WP is participating in a sub-network mostly sustained by papers about early education, and YR and YS are collaborating within a cluster based on four articles regarding educational development and assessment, and one article about childhood in education, respectively.

This seems to indicate that the clusters within the network are strongly grounded by common interests and backgrounds among scholars, founding disciplines of research. Actually, cluster G1 –where QP, UF, NL, SD, FJ, KS, NU, JX and NM are collaborating– is strongly based on coauthored articles about educational technology and computers in education, and this educational field seems to extend to other areas. For instance, G1 is connected to G4 –where KU and RV are participating–, which is a sub-network supported by papers on interactive learning environments (e-learning). In addition, G1 is linked to G6 –where K, PP and NU are collaborating– which is mostly sustained by papers about educational management and teacher accountability, and G1 is also connected to G8, where JZ, NY and VD are coauthors in articles on educational evaluation and scoring methods.
Regarding the values from Table 5-11, only authors QP, UF, WP and AV increased their degree and betweenness centralities, meaning that they coauthored more articles and facilitated the connections among scholars. Remarkably, before 2000, QP, UF and WP were part of the same cluster (see Figure 5-8), but since 2000 only QP and UF are still publishing together, probably because their background is in the same discipline (computers and education) while WP started its own thematic cluster (early education). More outstandingly, QP becomes the most relevant actor in the network, publishing a total of 39 articles (38 since 2000), all coauthored with other colleagues. Since most clusters seem to represent several sub-disciplines within educational research, the mentioned authors, along with the scholars from Table 5-10, are promoting research in specific subareas of educational research, and also encouraging multidisciplinary studies, enabling potential interactions among researchers within and across several clusters, confirming their central influences and leadership roles within the analyzed network as a whole.

Interestingly, although the amount of papers that a scholar coauthored seems to be relevant, it is equally or more important the number of connections that are based on those articles, along with their diversity. For instance, cluster G2 constituted 32 scholars who wrote just one article together. In other words, coauthoring just one article with too many scholars does not assure further collaboration and does not develop leadership roles among researchers. A similar situation is observable in G104 (2 scholars coauthoring 3 articles), G66 and G60 (3 scholars coauthoring 2 articles), etc. Therefore, the configuration of coauthorship, its variety and the number of articles seem to matter, taken as a whole. On one hand, prime examples of this are researchers QP, NL, SD, KU, NY, K, KS, NU, and JZ, who in total achieved more than 10 different connections by coauthoring articles with 2, 3, 4, 5 or more scholars, but with different patterns of authors (e.g., with other leaders in the network or researchers from other sub-disciplines) and on multiple occasions. On the other hand, scholars PP, FJ, RV, VD, JX, NM and UF appear to connect with colleagues within a big cluster, but in a similar manner to the previously mentioned scholars (i.e., with several authors in different instances), probably motivated by research topics of their specific areas of study, which is equally relevant for a collaborative network based on coauthored articles. However, it is important to highlight that inter- and multi-disciplinary collaboration in education are becoming relevant for the contemporary Chilean context, which seems to be an increasing tendency within and across other societies in several fields (Augsburg, 2006; Creamer & Lattuca, 2005; Oberg, 2011; Repko, 2008).
Taking into account the last point of the previous paragraph, the analysis of the international aspect of collaboration within this network is pertinent, in order to detect whether this kind of collaboration is mostly occurring within or across specific clusters, allowing inter- and multi-disciplinary research at a more global level, and not only within Chile. Thus, Figure 5-11 shows national and international linkages among scholars since 2000. Black nodes represent researchers in a Chilean institution and red nodes indicate a scholar in an international one.

One can note interesting patterns from the previous figure. First of all, more isolated scholars are located in Chile (18 out of 21), and just 3 scholars who are located abroad wrote
single-authored articles. This indicates that, since 2000, international scholars are collaborating more than in the period before 2000. In this regard, 67.9% of the 112 clusters present an international collaboration, and 2 clusters present 100% of scholars working abroad: G2 and G73 (both have a scholar with a double affiliation: with a Chilean and an international institution). In other words, just 36 clusters of the network present a collaboration formed only by national scholars (G9, G17, G23, G24, G25, G26, G29, G31, G35, G37, G38, G41, G44, G48, G51, G53, G60, G61, G68, G70, G75, G78, G81, G84, G85, G87, G90, G94, G98, G99, G101, G102, G105, G107, G108, and G112).

Interestingly, most of these clusters are comprised of 2 or 3 researchers. Thus, on the opposite side, there are a series of clusters with 4 or more researchers with 60% or more of their members working abroad, such as G39, G43, G45, G46, G47, and G49 (3 out 4 scholars), G27 and G32 (3 out of 5, and 4 out of 5, respectively), G21 and G22 (5 out of 6), G18 (6 out of 7), G12 (8 out of 9), G7 (10 out of 12), and G4 (19 out of 24).

In addition, it is important to note that two scholars working abroad are playing a leadership role within the network: JZ and KU. On one hand, JZ has the ability to connect scholars within G8 and also to communicate quickly with researchers from G8 to G1, and through longer pathways with G3, G4, G6, G30, G51, and G52. Similarly, KU can link several scholars within G4 –taking into account that most of them are working abroad–, and also connect them with other researchers in G1, G3, G6 and the other mentioned clusters, giving more chances to increase the international collaboration of the network.

Finally, it seems that some bigger “disciplinary” clusters (with 11 or more scholars) follow different patterns of international collaboration. For example, G9 (11 scholars) does not have any scholars abroad, and G5 (19 scholars) has only 1 researcher abroad. In the middle of this configuration, G10 (11 scholars) has 4 scholars working abroad, and on the other extreme, G7 (12 scholars) has a total of 10 scholars located outside Chile. It is important to highlight that these and other smaller clusters appear to just need one direct link to any scholar from G1 in order to increase the interdisciplinary research of the network, but also to get connections to the bigger sub-network formed by G1, G3, G4, G6, G8, G30, G51 and G52, where leadership roles are performed by several scholars.

In sum, given the information from Figures 5-10 and 5-11 and Table 5-10, it is possible to assert that, since 2000, there has been a proliferation of coauthored articles within the Chilean network of collaboration, and an important ratio of collaborative efforts include researchers located in international institutions. In contrast to the network before 2000, scholars are highly
linked to and integrated with other colleagues. Few of them are isolated (working alone), and most importantly they seem to develop disciplinary clusters through the network. Although most clusters are formed by 2 or 3 scholars—i.e., coauthoring articles with 1 or 2 more colleagues—, 46.4% of them are comprised of 4 or more scholars, indicating a robust arrangement of substructures of scholars that allows for the rise of leadership roles. In this regard, among the 15 researchers with the highest centralities, most of them are working in Chile (2 in international institutions). Regarding the scholars who appear in both analyzed networks (before and since 2000), only 2 of them seem to become key actors within the collaborative efforts through coauthored articles: QP and UF. They appear to be enabling the communication and pathways of collaboration among several scholars within their cluster and beyond, in a similar way to NL, SD, PP, KU and other analyzed researchers. Interestingly, most of these leader actors have gained important positions and awards throughout their careers. For instance, QP has been a professor in the Computer Science Department at a prestigious Chilean university, honored with the Chilean award for innovation in the Education category, and a prominent member of Chile’s Agency for Quality in Education; UF has been the director of a Center for the Development of Inclusion Technologies at a renowned Chilean university; NL has been the director of a graduate program and editor of a Chilean educational journal at a distinguished Chilean university; PP has been director of a graduate program and has led several educational research projects; etc. All this indicates a close relationship between researchers’ abilities for collaborating and leading the development of coauthored articles with the academic trajectory of the scholars who are immersed in those collaborative efforts.

### III. Summary

Collaboration has been a topic of increasing relevance in several fields, especially in the educational arena (Muijs et al., 2011). The examination of coauthored educational research seems to be a useful way of analyzing partnerships and collaborative relationships among several actors, such as scholars and educational institutions in specific regions, such as countries, continents or other societies of interest. Furthermore, leadership roles have been linked to networks and collaborative efforts (Balkundi & Kilduff, 2006; Brass & Krackhardt, 1999), which is also applicable among educational actors and contexts (Muijs et al., 2011).

This study examines collaboration and leadership at three main levels (a global perspective at the country, institutional and scholar levels), with a special focus on the Chilean context. This “zoom in-zoom out” approach offers a series of interesting results, as described in
previous sections. Thus, it is possible to answer the research questions stated at the beginning of this study.

How strong is the collaboration network in the publishing of educational research papers in Chile and Latin America?

The bibliometric and collaborative results at the country level indicate that there has been a significant number of published articles that have come from Latin America since 2000: a total of 5,204 publications. However, the general between-country collaboration among Latin American nations is only around 5%, which can be considered a relatively low rate. Not surprisingly, the number of published articles varies across countries, probably influenced by the population, number of scholars and investment in each country (Holmgren & Schnitzer, 2004; Huggett, 2012), but this does not imply a high between-country collaboration rate. The cases of Brazil and Mexico are remarkable. These countries have published over 2,400 and 1,200 articles, respectively (which represents almost 70% of total published articles from Latin America); however, they have the lowest collaborative rates with other nations (2% and 4%, respectively). On the contrary, less-populated countries, such as Cuba, Colombia and Chile, have comparatively published fewer articles in education, but have higher rates of collaboration. Actually, Cuba has the highest rate among the 19 analyzed Latin American countries (28%), and Colombia and Chile have rates close to 10%.

The case of Chile is particularly distinctive, taking into account that in terms of population and demography it is much smaller than Brazil, Mexico, Colombia, Argentina, Peru and Venezuela. In fact, Chile has a population comparable to Ecuador or Guatemala (CEPAL, 2013), but it has a between-country collaborative rate higher than the previously mentioned countries. Less optimistic are the cases of 4 Central America countries (Costa Rica, El Salvador, Honduras and Nicaragua) and one South American nation (Paraguay). In terms of population, these 5 countries are among the least populated in the region (CEPAL, 2013). The mentioned Central American nations are close to the country with the highest inter-country collaborative rate (Cuba) and the nation with the second most publications (Mexico). Paraguay borders Brazil (the most prolific publishing country) and close to other nations with high rates of collaboration, such as Colombia and Chile, but none of these 5 countries are collaborating with other Latin American countries. This impacts the Latin American collaborative network formed by 19 nations, which has a density of 0.193, i.e., just 19.3% of the potential collaborative connections among nations were evidenced. In other words, 66 out of 342 potential connections were actually realized.
For the Chilean context, a total of 338 articles were retrieved from Web of Science database, involving any researcher located in Chile. The general coauthorship efforts is represented by 73% of these 338 papers. Most no co-authored papers involved authors affiliated with a Chilean institution. More interesting, 49% of the articles included only scholars located in Chile, i.e., within-country collaboration. In this regard, 70% of the articles that involve researchers working in Chile include a collaboration of two or more different Chilean institutions, which can be considered high (Figure 5-5).

Furthermore, within the network of 45 Chilean institutions publishing articles, 32 organizations are actually collaborating. Similar to the case of the Latin American collaborative network, since over 25% of the actors are not collaborating with other nodes of the analyzed system, the density of this network is 0.0515, which means that only 5.15% of the potential collaborative connections were evidenced. In fact, 102 collaborative efforts among the analyzed institutions were executed, over a possible total of 1,980 connections.

Thus, the general inter-institutional collaboration can be considered properly large enough, with a significant potential to increase its collaborative rate. Additionally, it was detected that most analyzed institutions also collaborate with themselves, with 13 out of 45 collaborating only within the examined organization (these are actually the unconnected institutions in the inter-institutional collaborative network), involving only 21 educational research papers.

To what extent do Chilean and Latin American Higher Education Institutions engage on inter-institutional collaboration surrounding educational publications?

The country level results also enlighten the analysis of the inter-institutional collaboration. Taking into account that around 5% of the published articles from the region were part of between-country collaboration, a total of 244 articles involved an inter-institutional collaboration between at least two higher education institutions from two different Latin American countries. In this regard, and as was noted previously, since bigger countries published more than little ones, the former appear to have the highest amount of collaborative efforts. The cases of Mexico and Argentina (14 collaborative works), and Brazil and Mexico (13 collaborative articles) seem to point in that direction. However, countries with higher collaborative rates also have significant inter-institutional collaboration. Such is the case of collaborative efforts found between Chile-Argentina (10), Colombia-Mexico (9), Chile-Colombia, Cuba-Mexico (7), Brazil-Chile and Brazil-Cuba (5). The presence of Brazilian institutions in most analyzed collaborative efforts is noteworthy, taking into account that it is the only country in the region where
Portuguese is the official language (37 collaborative efforts). In the remaining nations, the official language is Spanish, where Mexico is leading the number of collaborative efforts within the region (52) followed by Argentina (41). Surprisingly, Chile has the same number of collaborative efforts as Brazil (37), followed by Colombia (29) and Cuba (16). As previously noted, all of these numbers are influenced by both the total number of publications and collaboration rates of each country. This analysis also reveals that, although the general rate of collaboration in the region can be considered low, the extent of the internationalization of inter-institutional collaboration is respectable, but it varies dissimilarly across the analyzed nations.

In addition, most nations in Latin America seem to collaborate preferably either within-country or with nations beyond the region, which suggest the presence of several sources of collaboration, and Chile seems to be a relevant case study, because of its comparatively respectable between-country collaboration, despite its size and also being a geographically isolated country in South America.

Thus, for the Chilean case, 73% of the analyzed articles were coauthored by two or more authors, and most of them were published in journals where English is the official language. Interestingly, among these articles, 51% involved international collaboration (i.e., a scholar located at an institution outside of Chile). Thus, the extent of the international inter-institutional collaboration appears to be large, taking into account that this collaboration is beyond Latin America, including countries from all the continents around the globe, highlighting the collaboration with the United States (44 appearances), England (13), and Spain (44). Collaboration with the mentioned nations and other English-speaking countries could explain why most scholars and institution are publishing in English, followed by Spanish and Portuguese. This also reveals that the extent of collaboration usually involves a language different to the native language of some involved actors. Moreover, English seems to have become the most predominant language in several trans-national activities, including research (Chauhan & Zhenfang, 2013; Wankhede & Kamble, 2014). Thus, the international dimension of collaboration appears to be a relevant aspect among Chilean institutions and scholars. Actually, the most popular configurations for articles with a scholar located in a Chilean institution involved 1, 2 or 3 more colleagues from abroad (Table 5-2).

Regarding the collaboration within Chile, and in a similar way to articles with international collaboration, most national collaboration involves 2, 3 or 4 scholars located in Chile (Table 5-2), and involves 32 out of 45 Chilean institutions, being the general inter-institutional collaboration rate around 30%, which can be considered relevant for the Chilean
context. Further, two Chilean institutions stand out from the rest (PUC and UCH), taking into account that they both are participating in almost 44% of the total analyzed published papers, and they also have the highest rates of inter-institutional collaboration: 24.5% and 37.7%, respectively. Except for four institutions, most of them have rates equal to or higher than 20% (Figure 5-5). Given the fact that 4 institutions are not universities (e.g., Central Bank, an educational research center, etc.), it is possible to argue that the extent to which Chilean Higher Education Institutions engage in inter-institutional collaboration surrounding educational publications is significant and includes institutions beyond Chile and even institutions that are not colleges, expanding the diversity of inter-institutional collaborative relationships.

What are the patterns of collaboration between institutions and researchers in the Chilean and Latin American context?

Sociograms provided by Social Network Analysis (SNA) allow for the mapping and exploration of patterns among the actors of several networks (Scott & Carrington, 2011; Wasserman & Faust, 1994). In the case of the Latin American collaborative context, most countries within the region are collaborating among themselves. However, there are 5 nations that are completely isolated in this network: Costa Rica, El Salvador, Honduras, Nicaragua, and Paraguay. On the other hand, countries with greater populations—and probably with a greater proportion of scholars per capita (Holmgren & Schnitzer, 2004; Huggett, 2012)—, such as Argentina, Mexico, Brazil and Colombia, top the list for number of different connections with other nations. However, these countries have dissimilar patterns of collaboration. As it has been highlighted previously, the case of Brazil is outstanding, mainly because is the only country in the region where the official language is Portuguese, but it is highly connected to other Spanish-speaking nations.

Thus, looking at Figure 5-6, Brazil is geographically connected with 7 different nations within the region: Mexico, Argentina, Chile, Cuba, Colombia, Uruguay and Peru. Recalling that the width of the links from Figure 5 is proportional to the coauthored publications among countries, the most recurring collaborative efforts of Brazil are executed with Mexico (a total of 13), followed by the collaboration with Argentina (7). This means that most Brazilian institutions and their scholars have coauthored articles with Mexican colleagues.

Consequently, Mexican patterns of collaboration are relevant in the Latin American context. Thus, Mexico is connected with a total of 8 countries: Argentina, Brazil, Colombia, Cuba, Chile, Venezuela, the Dominican Republic and Peru. In this case, the strongest
collaboration is with Argentina (14), followed by Brazil (13) and Colombia (9). It is interesting to note that, despite being geographically closer to Central American countries, Mexico has collaborated more with South American countries. The only exceptions are Cuba and the Dominican Republic.

The case of Cuba is also noteworthy. As it was noted previously, this country has one of the lowest number of publications in the region, but the highest rate of collaboration, and this is made with just three dissimilar countries: Mexico (one of the most prolific nations in number of publications), Brazil (a Portuguese-speaking country) and Chile (a small and isolated country in South America).

Argentina and Colombia are two other countries with significant numbers of connections to other nations in the region (8 and 7, respectively) and with similar patterns of collaboration. In this regard, besides collaborating with each other, institutions and scholars of these countries are also collaborating with colleagues in Mexico, Chile, Brazil, Ecuador, and Venezuela. In addition, Colombia is also collaborating with Peru, and for the Argentinian case with Uruguay and Guatemala. Furthermore, both countries are coauthoring most articles with Mexico (14 and 9, respectively), followed by collaborative efforts with Chile (10 and 7, respectively).

Thus, and probably surprisingly, Chile is the country that is leading the list of most connections within Latin America. In addition, despite not having the greatest number of published articles, Chile has a respectable collaboration rate, which allows it to achieve a significant number of papers that were coauthored with institutions and colleagues located in other Latin American countries (a total of 37, the same as Brazil). In this regard, Chile has a total of 11 different connections with several countries in the region, mostly publishing coauthored works with Argentina (10), Colombia (7), Brazil (5), and Mexico and Cuba (4 with each). In addition, it is important to note that most Chilean scholars are publishing in English, which seems to be a global way to gain visibility in important and prestigious journals around the world (Collazo-Reyes, Luna-Morales, Russell, & Pérez-Angón, 2008; Garfield, 1989). Moreover, English is also becoming a common language of collaboration for institutions and scholars where the native language is Spanish or Portuguese (the latter in Brazil’s case).

All these results indicate that language and geographic borders appear not to be limitations for collaboration, at least in the Latin American context, probably reinforced by scholars that study abroad –e.g., in institutions where English is the official language–, and also with the help of Internet and other information-communication advances (Kanuka, 2010).
The last point is probably clarified for the Chilean context, specifically. In general, the most popular arrangements of researchers for coauthored articles with a scholar located at any Chilean institution involved 1, 2 or 3 more colleagues, from 1, 2 or 3 institutions either from abroad or from Chile. Nevertheless, when the analysis is split in two spans of time at the scholar level (before and since 2000), there was a relevant increase in the total number of published articles, coauthored articles (i.e., collaborative efforts), and overall collaboration with scholars located abroad in the period between 2000 and 2014, in contrast to the period before 2000. Thus, limitations of convenient and faster ways of communication in the period between 1941 and 1999 could have played a relevant role in the few detected patterns of collaboration in that span of time, taking into the limited access to the Internet, having started its penetration into Latin America just in the early 1990’s (Everett, 1998). Actually, most researchers appeared in just one article, and almost 70% of scholars wrote single-authored papers, most of them located in Chile. Consequently, only 20 out of 66 articles were collaborative efforts, mostly based on just one article that was written by multiple authors. Accordingly, among the detected patterns of collaboration (Figure 5-8), 5 involved 2 authors, 3 included 3 authors, 4 involved 4 authors, 1 included 6 authors, and the most prolific involved 7 authors that wrote several papers in multiple ways.

In contrast, since 2000, 635 researchers published papers (before 2000, only 83 scholars published papers), publishing a total of 272 articles. The most significant change is that 83.5% of the articles were collaborative efforts, i.e., coauthored by 2, 3 or more scholars. Actually, just 23 scholars single-authored papers, which is proportionally lower than the period before 2000 (35 out of 83 scholars). Consequently, patterns of collaboration involved between 2 and 10 authors (67% between 2 and 4 authors). There were even 2 articles that included 12 scholars and there was an instance of a paper with 14 authors and another with 32 authors.

In addition, Chilean collaborative efforts have involved several research areas. Most collaborative papers have been published in Education & Educational Research journals, but there is also a strong collaboration in papers published in Educational Psychology, Computer Science and Special Education journals. These types of journals also could explain the cluster patterns for the Chilean context, especially since 2000. In this regard, 112 groups of collaboration through co-authored papers were detected (Figure 5-10). Although 30 of these clusters included more or less intensive collaboration between 2 authors (G83 to G112), and other 30 involved 3 authors (G53 to G82) –most of them and other bigger groups appear to be isolated within the entire collaborative network–, other clusters of 4 and 5 scholars (such as G51, G52, and G30)
appear to be connected to bigger collaborative groups. Actually, along with G3, G4, G6 and G8 (grouping 27, 23, 16, and 12 scholars, respectively), the mentioned clusters are connected to the biggest collaborative group (G1), which is composed of 80 scholars. These 8 sub-networks seem to be sustained by papers in different sub-disciplines within educational research, such as early education, educational assessment, computers in education, or e-learning, to name a few. In addition, since only 36 clusters in the entire network represent a collaboration formed by only scholars located in Chile, it seems that Chilean scholars and institutions are seeking and trying to incorporate international experts in the most recent patterns of collaboration. Probably, other isolated clusters could also be grouped by discipline, college department or other sub-structures of some institutions.

In this regard, clusters are also observable for the Chilean context at the institutional level. A total of 45 Chilean organizations have published papers, where 13 of them are not collaborating with other institutions (29%), and 7 different clusters were evidenced. Not surprisingly, the two oldest and most prestigious Chilean universities (PUC and UCH) are publishing more than any other, and also participating largely in inter-institutional collaboration (both of them represent 42.3% of the total collaboration). By observing Figure 5-7, it is possible to note that PUC and UCH are intensely collaborating with each other. This collaborative relationship is the most productive within the entire institutional network. Additionally, PUC is also directly connected with 17 different institutions from 6 clusters. It is important to note that PUC is also part of the biggest cluster (in dark blue), comprised of 8 institutions, including itself. In the case of UCH, it is directly connected to 13 different organizations from 5 clusters across the collaborative network, being this institution part of the second biggest cluster (in light blue), composed of 6 institutions. Thus, despite the fact that they are connected with each other, both PUC and UCH have different patterns of collaboration, but they share common connections to institutions such as UDP, PUCV, USACH, UTFSM, UCN, PIIE, and BANOCENTRAL. In this regard, PUCV, USACH, and UDP seem to follow strategic patterns of collaboration, mainly because they have developed greater collaboration with either PUC or UCH (or both), which is executed to a lesser extent by UTFSM, PIIE, and the other previously mentioned institutions. Interestingly, PUCV’s cluster is composed of organizations located in the central/northern regions of Chile, USACH’s cluster members are in central areas, and UDP’s cluster contains actors from central/southern regions. In addition, the substructure composed by UDEC, USS, UAUSTRAL and UPLA is composed of institutions from central/southern regions, and the universities of the UTAL-UANDES cluster are also located in central/southern areas of the country.
Remarkably, PUC is connected with several private Catholic universities or associated to a congregational church, such as PUCV, UCN and UANDES outside its cluster, and UCTEMUCO, UAH, UDD, UST, and UCSC within its cluster. As well, most of these institutions are located in the central/southern regions of Chile. On the other hand, UCH is connected with several public institutions or private-secular universities, such as UTFS, UDP and PIIE outside its cluster, and all the five institutions within its cluster (i.e., UV, UAI, UNAB, CNTV, and BANCOCENTRAL). These institutions are all located in the central regions of Chile. Accordingly, this evidence seems to indicate that there may be common research topics across institutions based on their foundations or their geographic locations. Additionally, there may be some policies that promote associations or partnerships among specific organizations, allowing for the development of certain patterns of collaboration among institutions and researchers.

What are the national and international patterns of leadership of Chilean and Latin American educational research papers?

Social network centralities that offers SNA seem to be a valuable technique to examine and determine the patterns of leadership at different levels of analysis (Hoppe & Reinelt, 2010), and collaborative settings can help to establish the roles and influences of involved nodes or actors on, for example, coauthored articles in specific contexts, such as educational research among certain nations, institutions, and scholars (Liu, Bollen, Nelson & Van de Sompel, 2005).

Thus, three centralities have become important in this type of analysis. Firstly, degree centrality refers to the number of direct ties of an actor, emphasizing that actors who have more ties may have favorable positions and be able to take advantage of the resources of the network as a whole. Secondly, betweenness centrality refers to the role of intermediary of some nodes within the network, underlining their strategic positions on paths in the liaison among several actors of the network. Finally, closeness centrality focuses on the distance from each actor to all others in the analyzed network, emphasizing the actors who can interact quickly with others (Wasserman & Faust, 1994; Freeman, 2004). The normalized values of these centralities consider the number of actors of the analyzed network (Luukkonen et al., 1993), which is helpful, taking into account that the number of actors may vary through the analysis of several networks. Each of the three mentioned indicators describe the locations of actors (nodes) in terms of how these locations relate to where the action (in this case, collaboration) is being developed in a network, and how this affects leadership settings and roles (Hoppe & Reinelt, 2010).
Thus, at the country level, there are a set of nations within Latin America that have no role in the network, such as the 5 countries that are not connected at all in the collaborative network, and also others with only 1 or 2 cooperative links, such as the Dominican Republic, Bolivia, Panama and Guatemala. This implies that they get low closeness and betweenness values; thus, they are far to play relevant roles within the network. On the contrary, the biggest and richest nations around the globe are called to play an important role in several networks or formal and informal groups structures (UNIDO, 2012), and by extension this may be the driving force for collaboration among institutions in the groups of countries involved. For the Latin American context, these countries seem to be Brazil, Mexico and Argentina, which actually are playing significant roles in connecting several countries through different patterns and ways. For instance, Argentina and Mexico have closeness values over 70% and normalized betweenness over 8%, along with a normalized degree of 44.4%, which is a result of the 8 direct connections out of a total of 18 possibilities. Their high closeness means that they are easily reachable by other countries through several pathways, and their relatively high betweenness suggests that these countries offer the opportunity to link less connected countries to others with more collaborative connections.

Actually, on one hand, Mexico is strongly connected and collaborating with Argentina, but also with Brazil and Colombia. Less intense is its collaboration with Cuba, Chile, Venezuela, Peru and the Dominican Republic. For the latter country, Mexico may be an important intermediary of collaboration with the rest of the mentioned countries. In turn, Mexico seems to be quickly reachable for Peru, Ecuador and Uruguay through short paths from Chile, Colombia and Brazil/Argentina, respectively. On the other hand, Argentina, besides its intense collaboration with Mexico, it also strongly connected with Chile and Brazil, and to a lesser extent with Colombia, Venezuela, Uruguay, Ecuador and Guatemala, being also reachable by Peru/Bolivia and Cuba by short paths through Chile and Brazil, respectively.

As one can note, Brazil is repeatedly mentioned for its direct connections to other countries, being easily reachable by nations such as Ecuador and Bolivia (via short paths through Colombia and Chile, respectively), but its betweenness is almost 4 times lower than Mexico, mainly because its bridger role between other countries is relevant and higher than Colombia, Peru, or Venezuela, but less intense than the roles played by Mexico or Argentina.

The role of Chile is certainly more impressive, being the country with the highest values in all the analyzed centralities. Thus, Chile has a total of 11 out of 18 possible direct connections with other countries, which represents 61.1% of the total. These connections are geographically
diverse, including collaboration with countries located in the South Atlantic (Brazil, Argentina and Uruguay), the South Pacific (Peru, Bolivia and Ecuador), the Caribbean and Central America (Colombia, Venezuela, Panama and Cuba) and North America (Mexico). In addition, Chile seems to be easily accessible by the remaining 2 out of the 14 interconnected countries of the network. In fact, Guatemala and the Dominican Republic can reach Chile through short paths on Panama and Mexico, respectively. Then, Chile gets a really high normalized closeness value, equal to 86.7%, which means that it is more reachable than all the other 18 countries of the network. Last but not least, Chile’s betweenness is 19.65%, more than twice of that of the next highest country in the list (Argentina), a value that actually highlights its role as bridge between several pairs of countries across the analyzed collaborative network.

In sum, the four mentioned countries are playing leadership roles through different patterns, but mainly based on their interconnections with each other. Thus, the Latin American collaborative network seems to have few leader countries, most of them located in geographically strategic positions. Nonetheless, Chile, which is located in the southern zone of Latin America, is the nation that most collaborates with other countries in the region, being easily reachable by other nations, and leading the role of intermediary between other countries. In addition, it seems that, in general, leadership patterns are lacking distribution: three leading countries are located in South America (2 in the Atlantic zone –Argentina and Brazil– and 1 in the Pacific zone –Chile–), and one in North America (Mexico), and none are in Central America (with Cuba being a potential leader, since it has the highest centralities among countries located in that zone).

At the institutional level there are more actors involved, which provides a better scenario for a cluster analysis. A total of 45 organizations –mostly higher education institutions– are publishing papers. However, 13 of them do not have a role because they are not collaborating with other institutions. Interestingly, most of these unconnected organizations are universities located in either the extreme North or South of Chile in less-populated cities, including UANTOF, UAP, UATACAMA, ULAGOS, UMAG and UTAR. Noticing that Chile is a long and narrow country –wedged between the Andes Mountains in the east and the Pacific Ocean in the west–, it seems that its specific geographic and demographic characteristics are affecting its collaboration and leadership roles at the institutional level, with some institutions becoming peripheral within the network.

On the contrary, the 5 Chilean higher education institutions that are leading the collaborative network are located either in the capital city (PUC, UCH, USACH, and UDP) or close by (PUCV). Moreover, 4 of them are universities with long traditions, having been founded
prior to 1900 (UCH, USACH, and PUC). The exception is UDP, which is a private university founded in 1982, when a national public policy allowed the creation of private colleges across the country. All these 5 institutions have a normalized degree centrality over 10% (i.e., 5 or more direct connections to other actors), a normalized betweenness greater than 3% (i.e., they are important intermediaries or bridgers for the connections of other actors), and a closeness over 5% (i.e., the path to reach them passes through 65 or fewer edges).

By far the most relevant institution is PUC, which has normalized degree, betweenness and closeness centralities of 38.6%, 25.48%, and 59.62%, respectively, followed closely by UCH, which has normalized centralities of 29.5%, 18.83%, and 55.36%, respectively. These values indicate that these two universities—which also collaborate with each other—are leading the network based on the number of direct connections to other actors within the network (degree centrality), but also in terms of their strategic positions on paths or the liaisons that they allow among other members of the network (betweenness centrality), and regarding their qualities to interact quickly with the rest of the network (closeness centrality). In fact, and taking into account that the network has 7 interconnected clusters, PUC and UCH can easily interact with actors of 6 and 5 different clusters, respectively, and can connect other actors across different clusters. In addition, PUCV and USACH seem to expedite the connection of PUC and UCH with the cluster composed by UDEC-USS-UAUSTRAL. As well, UDP appears to enable the linkages of the members of its cluster (UDP, PIIE, UAHC, UBB and UCMAULE) with other institutions from other clusters.

Therefore, at the institutional level for the Chilean context, there is a highly geographically centralized and low distributed leadership, where there are two main institutions that are leading this collaborative network (PUC and UCH). In addition, 3 others organizations (PUCV, USACH, and UDP) are leading their respective clusters, which appear to facilitate other potential collaborative efforts, noting that UCH and USACH are public secular universities, PUC and PUCV are private Catholic universities, and UDP is a private secular university, where the first four were founded before 1900, and the last one in 1982.

Finally, the most interesting situation seems to be evidenced at the scholar level for the Chilean context, mainly because of the large number of actors present in the network, and because the analysis can be executed for two specific spans of time with dissimilar characteristics, in order to identify a possible development of the collaborative network. Thus, a total of 709 scholars were publishing papers either between 1941-1999 or between 2000-2014,
and most researchers were publishing in the second period (a total of 635). Interestingly, only 9 members are present in both analyzed periods of time, which can be analyzed separately.

On one hand, before 2000, only 48 out of 83 scholars were coauthoring articles in education, distributed in 14 different clusters, all unconnected with each other, evidencing isolated collaborative efforts within the network. This structure, along with the fact that, in this period, most scholars just coauthored one article, seem to present few possibilities for leadership roles. Nevertheless, the cluster in dark blue of 7 scholars –comprised of OT, ZI, VK, MX, DR, IR, and HH– appears to develop some efforts towards more intense and diverse collaboration.

In this regard, the role of VK is the only one that stands out above the rest. This scholar wrote a total of 15 articles, 7 of which were coauthored with other colleagues, highlighting 4 coauthored papers with HH and 2 with OT. Consequently, VK has the highest degree centrality within the network (7.3%, supported by 6 direct connections), but most importantly, VK is the only actor in the network with a betweenness centrality other than zero (0.33%), indicating that VK is the only researcher acting as a bridger or intermediary between other colleagues, specifically within its own cluster. For instance, VK may facilitate the communication between HH and IR, or between MX and OT, just to mention a couple of paths. Finally, since all clusters are unconnected with each other, closeness centralities appear overinflated when the total number of actors of the network is taken into account. Thus, when this centrality only considers nodes within its specific cluster, VK has a closeness equal to 100%, indicating that this scholar is reachable by all the rest of the nodes in the dark blue cluster. In addition, all collaborative efforts of VK were developed with colleagues located in international institutions.

Therefore, the only leadership pattern before 2000 is settled within just one specific cluster, developed by just one scholar (VK), and totally based on articles coauthored with scholars working in international organizations. Taking into account Chilean geographic limitations and also the fact that, prior to 2000, the Internet and other technological communications had low rates of penetration and access in Chile (Hawkins, 2005), it seems that VK developed its international collaboration through specialization or professional experiences outside of Chile –e.g., a scholarship or grant, an internship or studying abroad, etc.–. Similar reasons can explain the important number of articles published alone by VK.

On the other hand, since 2000, the situation is totally different. A total of 635 scholars are grouped in 112 different clusters, and although most clusters are unconnected with each other, there are 8 clusters that interact with others: G1, G3, G4, G6, G8, G30, G51, and G52 (Figure 5-
Due to these interconnections across clusters, it seems that betweenness centrality is a more pertinent indicator to evaluate leadership roles in this network.

Thus, 15 scholars were detected with normalized betweenness centralities greater than 0.1%, a relevant value taking into account the number of nodes of the network. 7 of these 15 actors are in G1 (QP, NL, SD, FJ, KS, JX and NM), 3 in G6 (PP, K, and NU), 2 in G4 (KU and RV), and 3 in G8 (NY, VD and JZ). Thus, it seems that more central leadership roles are executed in G1, and more peripheral but important leading actors are present in G4, G6, and G8. In addition, researchers from G3, G30, G51 and G52 appear to only take advantage of collaborative relationships with specific scholars from G1 and from within their own clusters, making their roles more limited than actors in G1, G4, G6 and G8.

In this regard, the role of QP is by far the most important within the entire network, within the 8 connected clusters, and within its own cluster. Its degree centrality is 16.7%, which means that QP has 106 out of 634 direct connections within the entire network, and its value is 5 times greater than the second highest value (FJ). Similar to the network before 2000, this entire setting has several unconnected clusters, which seem to overinflated the original closeness values of the nodes. Consequently, it appears reasonable to normalize theses values taking into account the 148 nodes within the 8 clusters that are connected with each other. Thus, closeness centrality for QP would be 52.9%, which is equally the highest value, based on the mentioned substructure within the entire network. Thus, QP is highly reachable by other scholars, who can quickly interact with QP within the specified subnetwork. More importantly, QP’s betweenness centrality is greater than 6%—almost 4 times the second highest value of NL—, indicating that QP is the most important intermediary or bridger among other members of the network, providing the shortest paths between several pairs of scholars.

The other 14 scholars with the highest centrality values are also relevant actors, but to a lesser extent than QP. Although 5 scholars have just 5, 6 or 7 direct connections (NU, K, JZ, NY and VD) and also lower closeness values than QP, they have respectable betweenness values, playing the important role of gatekeepers within the network. The other 9 scholars have at least 10 different direct connections, along with proper closeness and betweenness values. In fact, collaboration within the mentioned 8 clusters is evidence of the rise of specific patterns of leadership. Thus, NU, K and NL are directly connected with each other, which may allow quick interactions between scholars in G1, G6 and G51 (Figure 5-10). A similar situation is occurring for scholars JZ, NY and SD, which are connecting G1 and G8 (VD seems to have a peripheral role in this substructure). In addition, KS is connecting G30 with G1, and KU, RV and QP are
connecting G4 and G1. As well, JX, FJ, UF and NM have strategic positions on paths that allow for collaboration between several substructures within G1. Arguably, the role of G1 stands out over the rest, mainly because it has direct connections with scholars in G3, G4 and G52, but most importantly, because the collaborative efforts within G1 allow expeditious interactions among the scholars of the 8 mentioned interconnected clusters.

Furthermore, it seems that each cluster represents a sub-discipline within educational investigation, mainly because they are strongly based on coauthored articles about specific topics, such as educational technology, educational management, educational evaluation, etc. Then, leadership patterns appear to be developed either by research areas or through interdisciplinary efforts. Even more, regarding the international aspect of the network, within the entire network there are 237 scholars located outside Chile (Figure 5-11), all them present in 76 out of 112 clusters. Within the 8 interconnected clusters, 59 out of 148 scholars are working abroad, and most of them located in G4 (a total of 19 out 23 scholars from G4). In addition, two scholars that are playing a leadership roles within the network are working abroad: JZ and KU.

Regarding the 9 scholars who appear in both analyzed spans of time, they appear to show changes in their patterns of collaboration and leadership across periods. On one hand, CU and IB seem to represent a poor development of collaborative efforts and eventual leadership, mainly since they became unconnected in the network since 2000, by single authoring their papers (CU also wrote alone before 2000). On the other hand, the most notable example is QP, who only wrote 1 paper before 2000, but then wrote 38 articles, being all these 39 articles coauthored with other colleagues. In addition, UF, WP and AV also increased their centralities, specifically their normalized degree and betweenness indicators. That highlights the role of UF, who collaborated with QP in both analyzed periods, and the actions of AV and WP, who appear to have started their own thematic clusters for research on school teachers and early education, respectively.

Therefore, leadership patterns within the collaborative network since 2000 appear to increase the number of relevant actors, being more distributed than before 2000, with 8 interconnected clusters where 15 actors are playing leadership roles. In addition, each of these 8 clusters seem to represent specific disciplines within the educational research, with an important presence of scholars working in Chile, but supported strongly by scholars located in international institutions in cluster G4. These patterns may be sustained by the emergence of Internet and other information and communication technologies, public policies and initiatives that promote more scholars and research at the country level, and possible regulations and directions that stimulate
cross-country and within-country collaboration at the institutional level (Bohen & Stiles, 1998; Bouwma-Gearhart & Adumat, 2011, Muijs et al., 2011).
Chapter 6

Conclusions

Social Network Analysis states that actors (such as countries, institutions, people, etc.) with high centrality indicators occupy important positions within systems (Wasserman & Faust, 1994; Wellman & Berkowitz, 2001), which have been linked to leadership roles (Hoppe & Reinelt, 2010). In addition, collaboration seems to be relevant in the academic world, with coauthorship efforts being a way to analyze it (Borner et al., 2005). Since people are naturally social actors within systems, these two frameworks (collaboration and leadership) may reveal interesting arrangements and information for the involved actors and policymakers.

Most previous studies have mapped and analyzed specific fields, including information systems (Huang et al., 2015), forensic science (Jeyasekar & Saravanan, 2015), business and management (Kumar & Jan, 2013). Others studies have also focused on specific locations, such as the United States (Börner, Penumarthy, Meiss & Ke, 2006) and Europe (Glänzel, 1995). Unfortunately, the educational field has not been analyzed in this way. Moreover, most studies have neglected the Latin American context. Thus, new and innovative research can be conducted for this context, based on datasets retrieved from major digital libraries, using relevant keywords to search all articles of interest (Börner, 2007).

SNA techniques were applied in this study, in order to detect patterns of collaboration and leadership for educational research among actors within several contexts. Three main levels were analyzed (country, institutional and scholar levels), gaining a more global perspective that unveils the potential differences in collaboration and actors’ properties within networks (Gazni, Sugimoto & Didegah, 2012). Since collaboration through coauthored articles implies bibliometric data, the latter can complement the main analysis by providing valuable descriptive statistics.

This section includes the conclusions drawn for this study, based on potential factors that influence the development of collaboration and leadership within networks. Then, some policy implications derived from the findings of this study are presented. Finally, recommendations and future research are suggested as a part of this examination.
I. Major ideas and inferences

The analysis of collaborative efforts and leadership roles from a network perspective allows one to figure out some issues that involve this kind of analysis, and also to evaluate some factors that seems to affect the production and rates of coauthored articles and leadership. These aspects appear to be important for the development of educational research communities, taking into account the network perspective used in this study, the role of technology, language and geography, and also the international dimension of educational research.

Collaboration and leadership from a network perspective

Nations, institutions and the groups of people within them can be viewed as a complex social systems. In particular, people can be seen as equivalent to a nervous system and its interconnected communication links, cooperatively creating a “global brain” (Bloom, 2000). Thus, there is a worldwide trend toward the development of a more global knowledge creation and dissemination dynamics, taking advantage of the incorporation of social systems in concert with technological support (Börner et al., 2005).

Coauthorship, as a way to evaluate collaboration, appears to be central in studies of connectivity and communication configurations among researchers within specifics fields, mainly since those arrangements facilitate the development of a network among scholars (Melin & Persson, 1996). In addition, leadership through collaboration and team building has been also relevant for detecting the roles of individuals within the higher education sphere (Ferren & Stanton, 2004). Thus, for the purpose of this study, the analysis of the features of multi-authored papers is relevant, in order to detect bibliometric structures that influence communication and leadership among social actors.

In general, collaboration rates and practices vary greatly across and within scientific disciplines and influence the academic performance and its scholarly communication. Thus, collaboration seems to be historically more intense in scientific and technical fields than in the social sciences and humanities (Ding, Foo & Chowdhury, 1999). According to the results of this study, this also seems to be the case for the Latin American and Chilean context in the educational field.

Traditional network models presume total randomness, in other words, actors are interconnected independent of the number of links they already had (Bollobás, Kozma & Miklós, 2008; Newman, Watts & Strogatz, 2002). On the other hand, a much used and practical assumption is that it is more likely that actors link to those actors that already have a large
number of links, a theory that has been labeled as “preferential attachment” (Barabási & Albert, 1999; Newman, 2001). Thus, networks increase constantly by the accumulation of new actors, and the latter preferentially join to already well-connected actors and neighborhoods.

In this regard, since the analyzed networks are sustained by the knowledge background and academic interests of their actors (i.e., everyone is publishing research in educational journals), it would seem that collaborative networks and leadership roles in those networks are not necessarily randomly nor uniformly distributed. When a zoom-in/zoom-out examination is carried out (i.e., a global perspective, passing through a country, institutional and scholar levels of analysis), with a special focus in Chile, each network level appears to be apt for concentration of collaboration following particular patterns in different ways.

Thus, the first level of analysis focused on countries of Latin American. As expected, nations such as Brazil, Argentina and Mexico, which are investing significant resources in R&D (Altbach, 2007), are assuming relevant roles within the analyzed collaborative system. These countries hold research universities with longstanding traditions, along with critical masses of scholars (Altbach, 2007). Taking this into consideration, the role of Chile was, surprisingly, the most impressive in the region, despite its geographic isolation and smaller population, which leads to its analysis at the institutional and scholar levels.

Thus, cluster analysis for the Chilean case at the institutional and scholar levels shows a concentration of collaboration in specific nodes, with leadership roles located in few actors. Cluster analysis also displays that many members of the analyzed networks are directly connected to at least one actor from another cluster. Additionally, some actors appear to belong to multiple clusters, such as PUC and UCH at the institutional level, and QP, NL and SD at the scholar level since 2000. This proves that different clusters and their members can make connections through these leading actors, which is emphasized by the higher degree, betweenness and closeness centralities of the mentioned nodes.

In addition, institutions and scholars from a same cluster seem to be grouped by geographical proximity. For instance, at the institutional level, UCH’s cluster members are from central regions of Chile, and PUC’s cluster members are located in central-south zones of the country. Similar settings appear at the scholar level, but probably these also include intra-institutional collaboration. For example, some members may work in the same graduate school or department, where usually scholars may have adjacent office locations. On the other hand, countries’ collaborations within Latin America appear to be not affected by geopolitical borders, given the fact that it was found cooperation among countries in North, Central and South
America. Nevertheless, leadership roles at the country level seem to be influenced by a country’s geographic and demographic characteristics, taking into account that there are no leadership roles among nations in Central America, where most of the less-populated and smaller countries are located.

Examination of the data reveals that, at the scholar level, the immersion of new actors since 2000 has expanded the rise of disciplinary clusters or research fields, which has in turn promoted collaboration and leadership based on collaborative intra-disciplinary and multi-disciplinary studies. This is, to some extent, tied with the previously mentioned point about scholars working and collaborating in the same kind of department from the same university, but also from different institutions or schools.

In this study, at the scholar level, changes in network and nodes properties, such as density, clustering, and centralities generated across time, are recognized as an evolution. Thus, when two different spans of time was contrasted for the Chilean context (before and since 2000), a positive change was noted in the network. Firstly, the network scale expanded for the inclusion of new scholars. Secondly, more scholars appear to be intensely collaborating and most of them are developing sub-networks. In the case of the scholars present in both analyzed periods, individuals’ centrality values of some actors has increased. For instance, QP, UF, WP and AV increased their degree and betweenness centralities. This likely indicates that their research is present in more collaborative papers, involving more scholars in cooperative instances, and also indicates that they are ascending as leaders into core positions either in the whole network or in specialized clusters.

Regarding leadership from a network perspective, it is important to recall that, for this study, leadership has been framed as the capacity to effect change or to make a difference, in either individual institutions or higher education systems. Consequently, this is likely a function not just of natural attributes or learned behaviors, but also of the policy contexts in which institutions and their leaders operate (Johnstone, 2011).

Regularly in the scholarly literature, leadership and management are used interchangeably. However, at the university and scholar levels, leadership refers generally to the abilities to establish institutional strength, guidance, and cohesion by influencing people, while management denotes the skills for executing institutional policies and decisions, along with the activities of the institutional administration. Nonetheless, these two qualities are not mutually exclusive, and for the analyzed context, ideal leaders of higher education institutions should exhibit a balanced possession of both qualities. Thus, within its most basic aspect, leadership is
all about managing change. Moreover, “university leadership can only be as good as the institutional and global context in which it is exercised.” (Hayward & Ncayiyana, 2011, p. 17).

Collaborative groups or networks provide opportunities for their respective actors to play new roles and exhibit leadership. Given the results of this study, from the country to the scholar levels, passing by the institutional one, effective leaders can be identified, but they also should be supported, preserved and empowered, mainly through enlightened policies of governments and, to some extent, the private sector. In this regard, Chile and the rest of the Latin American nations should strive for the greatest amount of effective higher education leadership as possible.

Given the analysis at the scholar level for two different periods and the previously mentioned “preferential attachment” theory, it seems that for new authors, (i.e., those who appear for the first time in a published paper), it is more likely that their first paper will be coauthored with somebody who already has a significant number of links through multiple coauthored articles. As a consequence, “senior” scholars who already greater links also have greater chances to increase their coauthored works. More importantly, a large number of new connections between senior and junior scholars would rise, along with new links among old researchers as the network evolves. Both types of links are important for the dynamic of the collaborative network.

Newman (2001) found that this is actually happening in scientific collaboration networks in physics and biology fields. This also seems to be happening for the Chilean analyzed context, and just looking the case of scholars QP and UF provides justification for further examination in future studies.

At the scholar level, several studies have shown strong and relevant relationships between collaboration, the increase in academic knowledge, and active roles in scholarship environments (Abbasi, Altmann & Hwang, 2010; Ding, 2011; Jiang, 2008; Pao, 1981, 1992). This obviously affects other levels of analysis, such as institutional and country levels. Some of these studies have noted the presence of a small core of exceptionally active scholars, surrounded by a large floating population of researchers who have collaborated with these detected leaders on perhaps only one or two works.

In fact, Pao (1992) found the existence of two types of co-authors: the “globals,” who appear to co-author with colleagues beyond their own group, and the “locals,” who seem narrow in their actual collaboration. The globals tend to consist of a small group of highly productive researchers, while lower-rank locals constitute a much larger pool of individuals. This study supports the principle that scholar collaboration can serve as a means to achieve research
progress, and also as a mechanism for promoting the prominence of highly productive and collaborative researchers, where some global actors stand out over most local actors.

Other theories emphasize the importance of the quality of relations between leaders and followers, called “transactional approaches”. They propose that effective leadership flows from the expansion of the reciprocal benefits that the leader and followers offer each other. This reciprocal influence eventually becomes an “inclusive leadership”, i.e., relations than can achieve things or goals for mutual benefit, suggesting that leaders must firstly build up a support base, by “doing things with people rather than to people” (Hollander, 2009, p. 3). Additionally, Bennis (2000) and Riggio, Chaleff and Lipman-Blummen (2008) argued that followers have to be encouraged to become active participants in leadership initiatives, taking into account that, in general, a greater distance from the group involves more resources to produce ultimately an inferior outcome, weakening both leadership and the group.

To some extent, this study supports the principles of these theories, taking into account that collaborative relationships have, by definition, mutual benefits, and the participation of more scholars in more coauthored papers expands the quality of links, initiating and developing inclusive leadership. This should be complemented by qualitative studies that focus on the characteristics and practices of people in core positions and in peripheral locations.

It has also been argued, and following the distributed leadership principles, that successful planning, implementation, and execution of collaborative efforts cannot rely on the leadership role of just a single actor. Since its beginning, strategic planning requires proficient and appropriately empowered leadership at all operational and department levels and in most sections of institutions (Hayward & Ncayiyana, 2011).

For the Latin American and Chilean contexts, it was noted that educational actors are definitively sharing knowledge and skills, developing collaborative works that can enhance the reliance upon and aspiration for further cooperation, taking into account that degree centralities at the scholar level indicate some kind of evolution based on the development of relationships among several actors.

At all levels, it was detected that the roles that each actor plays throughout the analyzed networks are manifold, and that there are combinations of links and centrality indicators that provide better results. Sometimes the reason for success of the partnerships lies in their diversity of members. Different actors bring their specific expertise, forming a “knowledge community” that combines this diverse expertise to achieve a common and shared goal (in this case, coauthored published articles).
Thus, leadership and collaboration are critical for educational actors to carry out successful activities. It may be that their patterns have been narrowed, but also encouraged by several factors. These elements are examined in the following sections.

*The role of geography, language, and technology*

The Latin American context is interesting to analyze for several reasons. In general, most countries in this region are labeled as “developing countries”, adapting to the new ways of Information Communication Technology (ICT) (Chauhan & Zhenfang, 2013). Almost the entire region shares a common language (Spanish), along with the presence of different geographical limitations (the Andes Mountains crossing South America; a narrow isthmus joining North, Central and South America; and the Pacific and Atlantic oceans bordering the western and eastern coasts, respectively).

In the late 1970’s, Frame and Carpenter (1979) argued that, for international collaboration, aspects such as geography and language had important roles in resolving who collaborates together in the worldwide community of scholars. For Latin America, and particularly in Chile, these factors appear to have different degrees of influence across and within countries.

In this regard, the lowest between-country collaboration rates of Brazil and Mexico seem to be based on language and geography, respectively. On one hand, Brazil is the only country in Latin America where the official language is Portuguese, so it seems likely most Brazilian institutions and scholars are publishing in this language within their country. This is supported by the existence of several journals in Portuguese with longstanding traditions that follow open access models (Cabrera, 2015; Parreira & Carvalho, 2005). In the case of Mexico, this country shares a border with the United States, which seems to be a more interesting country for collaboration, mainly because the prestige of their higher education institutions and scholars (FOBESII, 2013).

Regarding international collaboration, Ding and his colleagues (1999) argue that this should be fairly high for smaller countries, mainly because there is a greater share of scholars outside these nations, therefore, greater is their chance to collaborate with international researchers, achieving recognition and higher status. However, this seems not to be the case for the Latin American context, where most small countries are either unconnected or have fewer links in the analyzed collaborative network.
In other words, the collaboration sources may depend on other kinds of geographic factors. Thus, a low between-country collaboration within Latin America may be reinforced by a high within-country collaboration, or by a collaboration with other nations beyond Latin America.

Furthermore, and according to several studies, the geographic locations of scholars seems to play a relevant role in who coauthors with whom (Börner et al., 2006). In other words, physical proximity is relevant, even in the Internet age (Börner, 2006).

This seems to be the case for the Chilean context, where most universities are located in the capital city. Nevertheless, Chilean private universities created since 1981 appear to follow different spatial configurations when they are contrasted to either public institutions or private colleges created prior to 1981. The latter usually have one or more campuses located within a single region. For instance, all UCH and PUC campuses are located in Santiago, the capital city and the most populated Chilean city. In addition, USACH, PUCV and UDEC have major campuses in Santiago, Valparaíso, and Concepción, respectively. On the contrary, private institutions such as UCENTRAL, UST and INACAP have different colleges and faculty across the country (although their headquarters are mostly in Santiago). These and other private institutions showed lower levels of collaboration and leadership. The exception was UDP; however, this private institution is solely located in Santiago. It is important to note that Valparaíso and Concepción are the second and third most populated cities in Chile, respectively, and one can find fewer inhabitants in locations in the extreme North and South of the country, where, in turn, there are fewer well-connected and collaborative institutions, as well as an absence of leadership roles.

This examination indicates that, at the national level, in Chile there seems to be a strategic advantage for institutions to be located in Santiago, and likely to a lesser extent in Valparaíso and Concepción, mainly because there is a strong centralization of economic, political, and social activities and events in the Chilean capital city. Actually, private, public and other bureaucratic processes occur in Santiago (Monje, 2002). For example, Chilean governmental headquarters are mostly located in the capital city (The Palace of Government, the Ministry of Education and other public educational agencies). Only the National Congress is located outside of Santiago (this is actually in Valparaíso, close to Santiago).

Thus, this combination of available resources and position enhances the centrality of the universities in the capital city, while emphasizing the peripherality of universities located in the extreme South and North regions. Private institutions seem to support a decentralization of Chilean research, placing some colleges in several regions of the country; however, these efforts
do not seem to be enough to increase substantially the collaboration coming from outside of Santiago, especially from the extreme North and South regions.

Regarding the role of language, during most of the 20th century and into the 21st century, English seems to be the predominant language for scholarly communication and research—for international conferences and meetings, web-based social networks, as well as journals from both English and non-English speaking countries (Crystal, 1997). Other major western languages, including Spanish, French and German, are also used but to a lesser extent. Other languages—mainly local languages—may be used for teaching and local publications, but with a limited international impact for academic research.

According to Altbach (2011), language is one element of the peripherality of some institutions and scholars in developing countries. Accordingly, for Latin American and Chilean scholars, not learning a foreign language, such as English and perhaps others, may be considered a flaw at any level, diminishing their chances to be part of the discussion in important communities, such as international academic spheres, in an increasing global and multilingual world (Crystal, 1997).

In the case of Chile, most published articles were in journals where English is the official language, and it was evidenced collaborative efforts with countries in Europe, Asia, Africa, and Oceania. Moreover, Chile collaborates more with the US than Latin American nations.

It may be assumed that universities should mainly operate in the international languages of scholarship, although they may disseminate their research and analysis in their local language (Altbach, 2007). It seems likely that current and future educational scholars from Chile and Latin America will face this paradox, which probably should be addressed with a balanced number of publications in several languages, in accordance with the target-readers for each research.

Finally, research collaboration has been impacted by the Internet age. Advances in information and communication technologies (ICTs) are closely related to globalization, affecting universities and researchers in many ways, mainly through the use of ICTs for scholarly communication around the globe. According to Altbach (2011), ICTs have offered exceptional access to contemporary academic information to researchers in developing countries, especially in Latin America. To some extent, this provides a better source than the insufficient libraries and other traditional scientific materials that exist in most developing countries. Most importantly, and in accordance with the results of this study, the Internet has accelerated and facilitated the interaction and communication among scholars worldwide, by radically reducing their traditional isolation (Altbach, 2011). In fact, when Huang and her colleagues (2015) contrasted the pre-web
and post-web stages, they concluded that co-authorship increased in the field of information systems.

For the Chilean context, when the periods before and since 2000 were contrasted, a very sharp reduction in single authored articles was noted. On the other hand, the average number of authors per article, total number of articles, and international collaboration were increasing. There is a strong chance that these trends will continue in the future, coinciding with changes and the developments of more and better options of communications within the country and across the world (Bartling & Friesike, 2014; Hawkins, 2005).

Thus, the Internet and ICTs on research collaborative networks have facilitated for scholars from developing countries to keep up-to-date with investigative trends, to participate in additional academic deliberations on a more equal basis, and prominently, to communicate with international colleagues.

At the scholar level, the analysis of two different spans of time seems to indicate that the early stage of successful partnerships has overcome the communicative, technological, and geographical barriers existing among scholars within Chile and across the world.

However, Altbach (2011) argued that some researchers are still peripheral in developing countries. In spite of the ongoing expansion of the Internet-based knowledge systems, some of the Chilean institutions located in less populated cities far from Santiago still operate in relative isolation. This deserves further investigation and research.

**Globalization and Internationalization of research**

Global realities are present in any process of change and advancement. Globalization has spurred an international knowledge structure in which academics and universities across the world may be involved, and also has encouraged that some of the larger developing countries focus on the progress of research universities, moving away from their peripheral status at the worldwide level (Altbach & Balán, 2007; Salmi, 2009).

Within the academic research aspect, probably the most notable facet of globalization is the development of a worldwide competition for academic expertise, spread out in part by the large number of graduate students who study abroad.

In general, *world-class* is a concept to designate a university that is among the most prominent and salient academic institutions around the globe (Altbach, 2003). Almost all of the world-class universities are located in the foremost English-speaking countries or larger industrialized nations. Thus, for Chilean and Latin American graduate students, foreign study is
considered to be more prestigious than receiving training in their own countries. These people follow the developments in cutting-edge research while striving to maintain connections to colleagues from the countries in which they studied.

An important number of students who earn their degrees overseas do not return home. The so-called brain drain seems to be a complex phenomenon. In some cases, people from developing countries employed in the Northern hemisphere of the world return home when fascinating job opportunities appear, or after governmental improvement of some national issues, such as living conditions, academic infrastructures, or the intellectual and political climates (Altbach, 2011). Those who do return and participate in the national academic profession usually bring back the contacts and connections from the nations in which they studied. This benefits not only the scholars, but also their institutions and countries.

In addition, and taking into account the work of Boyack and his colleagues (2005), the international collaboration analysis—such as the one used in this study—shows the local scholarly knowledge that can be used as a way of accessing and inserting in global scholarly maps. In other words, scholars working in national settings with colleagues abroad may act as bridgers of collaboration and knowledge.

In the context of globalization, developing countries, such as those in Latin America, require access to the widespread world of science, and researchers represent a central link to the international knowledge network. In addition, universities and colleges that aspire to be research-oriented should engage in international academic networks and collaborate with institutions and researchers around the world. However, the costs of these issues for research universities is a particularly critical problem for developing countries with financial issues and no experience in developing such institutions (Altbach, 2007).

Furthermore, and according to Altbach (2011), it is probable that a significant number of scholars in most developing countries hold just bachelor’s degrees. Usually, those in senior academic positions have higher academic degrees; however, the rest have modest credentials for their jobs. A series of countries, including Brazil, have implemented fruitful endeavors to raise the credentials of their academic professionals by providing opportunities for study, but also increasing the minimum diplomas for working in academia.

For the Chilean context, during the last decades, the development of new scholars at international universities, along with the promotion of more and better educational research, have received the support of Chilean government agencies. In this regard, two seem to be key players in this development.
On one hand, the National Council for Scientific and Technological Research (CONICYT) is the main Chilean public funding agency for research and development of “advanced human capital”. In the period between 1990 and 2002, CONICYT’s budget was quadrupled, reaching almost 18% of the overall government higher education expenditures (Bernasconi, 2007).

Training outstanding students was a concern that was addressed in 1981, when a scholarship called Beca Presidente de la República was created to provide financial assistance for students in primary, secondary and higher education. This scholarship eventually extended its benefits to post-graduate work in Chile and abroad.

More interestingly, in 2008, CONICYT initiated a program to develop the Chilean human capital through an initiative based on scholarships to study abroad. This program is known as Becas Chile, which aimed to increase the qualifications of 30,000 superlative students to attend the best colleges and universities of their choice around the world, supported by a peer-review revision of the applicants’ documentation (OECD & World Bank, 2010).

The second key player is FONDECYT, an agency dependent of CONICYT. Since 1982, the majority of competitive funding for research in Chilean universities has been under the purview of this agency. FONDEF is another fund for long-term projects. In addition, since 2006, a special competitive funding for educational projects (FONIDE) has also gone to support Chilean scholars, yet its assigned resources are smaller than FONDECYT or FONDEF. These programs have promoted among Chilean universities a more active research, with five institutions usually acquiring most of the funding: UCH, PUC, UDEC, USACH and UACH. Overall, the mentioned universities have raised their research productivity, which is usually measured by the number of ISI-indexed publications (Bernasconi, 2007), and ultimately, these programs have also encouraged international collaboration, in order to strengthen the quality of the proposed research initiatives.

It is pertinent to underline that globalization enables most individuals to join the worldwide sphere of science, scholarship, and inquiries, through better communications supported by modern information technology, the global circulation of highly qualified people, and so forth. But at the same time, participants of the globalization process seem to be forced to yield to “the pressures of an unequal global knowledge system dominated by the wealthy universities, and imposes the norms and values of those institutions” (Altbach, 2007, p. 17). Thus, globalization in Latin American countries should work to appropriately balance these standpoints.
Given the mentioned factors and the results of this study, a series of policy implications arise that need to be addressed. Some of these are discussed in the following section.

II. Policy Implications

Greater collaboration among actors in the educational field, both across and within national boundaries, has a series of wide ranging benefits, such as an impact on educational progress and innovation, having both theoretical and practical implications for national policies. In this regard, it raises both challenges and opportunities for countries, universities, and scholars.

Like other works using association networks, and in order to improve academic knowledge and scholarly management, the type of analysis presented in this study can be used by researchers, managers, professionals, policymakers and other actors of the educational community to, for instance, select new collaborative connections, to improve research support, or to restructure the relationships with current coauthors, among other actions.

Accordingly, these collaborative networks must be supported directly and indirectly by several policies and strategies at different levels, in order to develop more successful partnerships and flows of knowledge. In turn, these policies imply several challenges and opportunities for actors within the analyzed networks, some of which are analyzed in this section.

**Forming successful partnerships**

Partnerships can be difficult to initiate and maintain because they are influenced by many factors. For instance, they are commonly dependent on leadership roles, but leaders may be constantly changing, affecting the establishment of educational partnerships (Lauer, Wilkerson, Goodwin & Apthorp, 2002).

In addition, policies and administrative procedures for partnerships usually do not accommodate collaborative goals well (in this case, a published paper in a peer-review journal). Unfruitful discussions about who should be the first author, who manages the funding, etc. may arise. Accordingly, formal and informal collaborative guidelines set by participating institutions may require modifications, especially when senior university faculty members initially choose not to engage in collaborative works. Even more, competitive institutional forces that value and reward the publications of research may produce some perverse incentives, such as additional payment for academic productivity though publications (Altbach, 2011; Campoy, 2002).
According to Bullough and his colleagues (1997), faculty members at contemporary universities’ schools of education typically arrange themselves into three major groups: content-driven scholars, who usually carry out their research in specific disciplines (e.g., psychology); field-focused researchers, who develop research in specific topics (e.g., the methods of teaching); and clinicians, who focus on teaching and supervision of students rather than leading research. These groups regularly align hierarchy, prestige and reward of scholars based on traditional university value organization. Additionally, and especially in Latin America, schools of education strive within an outdated university structure to obtain deference for their work equal to that of the appreciated and valued schools of science, mathematics, medicine, and engineering. All these aspects should be addressed for the analyzed context, promoting interdisciplinary studies, and the modernization of institutional practices.

Accordingly, some policies should anticipate the need for and development of a new sort of university faculty, highly motivated to collaborate with other colleagues despite traditional and bureaucratic practices. These so-called boundary spanners are important for representing involved collaborative institutions perspectives, and for conducting the primary research at their institutions (Lieberman, 1992). Eventually, these boundary spanners would be well respected and esteemed by the already positioned research-driven faculty, since scholars who are focused on research typically gain status, influence, and power within faculties (Campoy, 2002). It is important to note that building proper collaborative relationships is more difficult if the boundary spanners keep changing.

In this regard, leadership roles provide an anchor to seek new ways to cooperate, taking into account that encouraging a process of active research for educational changes and improvement, within Latin American nations and across the world, requires the assistance of leaders to send signals to staff that collaborative work is valued and important.

Thus, partnerships require the support of informal leaders –those without a position of power or formal authority–, which are vital to the collaboration as formal leaders. In this sense, contemporary literature on organizational leadership asserts that organizations –including educational institutions– should abandon the myth of the hero-leader (Senge, 1999). Change occurs when leadership responsibilities are shared among many people. Distributed and broad leadership facilitates that academic staffs to join suitably in collaborative projects, and it also ensures that the continuity of projects and change initiatives are less likely to weaken when some formal and informal leaders leave the involved institutions (McREL, 2000).
On the other hand, partnerships require adequate resources to operate properly, and collaborators require pertinent talents and abilities to make the best use of these resources. Collaboration and other kind of partnerships should not be worried whether the collaborators devote an identical amount of resources. What matters is the engagement to the collaboration. Because collaboration is a crucial component of any kind of partnership, it is important to invest and dedicate time to examine partners’ collaborative skills and to provide training in accordance with the projects involved, if necessary.

As it was noted in this study, leadership is critical to gaining resources for partnerships, maintaining collaboration, and facilitating the tasks. The key component is that leadership of the collaborative network needs to be sustained so that even the departure of one or two key actors does not compromise successful partnerships. Thus, for the analyzed context, leadership should be considered broadly as a group of actors who share knowledge and skills for guiding and carrying out coauthored articles.

The analysis of this study confirms the development of collaborative networks comprising successful co-authorship teams. As new studies and outcomes emerge through these networks, new interested parties and insights are obtained. Scholars should be inspired to work on the same or other related research fields, taking into account that researchers often cooperate to investigate problems that are difficult to address by an individual working alone (Ding, Foo & Chowdhury, 1999).

For developing new leadership or collaboration itself, the critical issue involves converting partnership motivation to partnership goals. In this regard, several policies should be put into place to promote collaboration in the educational field. According to Börner (2007), there is increased specialization of researchers, along with a fragmentation of scientific works, which connects to a world of unexploited chances for collaboration. Accordingly, “we simply do need better tools to keep track, access, manage, and utilize our collective scholarly knowledge and expertise” (p.808).

Increasing flows and platforms of knowledge

According to Yin (1981), the general analysis of organizational arrangements in education delineates how knowledge is used when organizations have to collaborate. Thus, findings in these kinds of research have established that when greater networking occurs, more knowledge utilization is involved.
Taking into account this point, for the knowledge utilization process, one important insight that emerges is the recognition that research actors themselves can be both producers of investigations as well as spreaders of information. As it was noted by Yin (1981), if one only outlines knowledge utilization in terms of the utility of some concrete products, such as single authored or coauthored articles, one largely overlooks a crucial aspect of the knowledge utilization process.

According to Börner (2007), maps and networks of science and knowledge can help research actors to find places of their interest, because they provide global views of large amounts of knowledge. Thus, institutions and scholars can judiciously make use of the best knowledge sources, easily discover the best collaborators, and quickly recognize the best research opportunities.

For the Chilean case, the main issue is that there is a strong centralization of the educational research, mostly developed in the capital city. This may limit a larger impact of the developed knowledge on the entire society, taking into account that a lack of studies from local or specific regions were detected (from areas in the extreme north and south of the country).

The creation of two new public higher education institutions in regions of Chile previously without this kind of university seems to be a step in the right direction. Nevertheless, it is uncertain what roles these institutions will play within the collaborative network. Additionally, the quality of the services and research provided by these institutions may be of some concern (Bernasconi & Irarrázaval, 2015). In Chile, and Latin American in general, several efforts of academic standards and quality assurance mechanisms has been executed, through the creation of independent national accreditation agencies and committees (Holm-Nielsen, Thorn, Brunner & Balán, 2005)

This last point can be inferred from the limited presence of regional and novel private Chilean universities in the analyzed collaborative network, where most of these universities are not publishing ISI-indexed publications. Certainly, the creation of high-quality ISI-indexed Chilean educational journals would provide a good opportunity for scholars from organizations in extreme geographic regions in Chile or from private institutions without major experience in educational research to get further involved. The development of educational conferences and congresses within Latin American countries may also support the connections of the mentioned actors with others in national and international ambits for the pooling of different sources of knowledge.
There is a general acceptance that global competitiveness and economic growth are progressively driven by knowledge and higher education institutions have a critical role in that context. They help countries to be active participants in global economies by training skillful and productive workers and developing and disseminating new research and ideas (Salmi, 2011). Universities and colleges can also play a crucial role in their regional and local settings (Yusuf & Nabeshima, 2007).

According to World Bank (2002), high-performing university systems include a variety of institutional models. Within higher education systems, research universities have a critical role in preparing high-level experts and investigators necessary for societies, and in turn they develop new knowledge. In general, each type of institution (research-oriented or not) play an important role, and reaching a balanced development among the diverse actors of the system should be a main concern of many nations. In this sense, Chile and the rest of Latin American governments may promote upgraded networking systems among their higher education institutions. This should be in balance with the increasingly pressing priority of most developing countries to guarantee that their top universities are actually functioning in the most advanced intellectual and scientific environment, despite the recurrent financial restrictions that most of them face (Salmi, 2011).

Perhaps, the main element of excellence for top universities is the presence of a critical mass of preeminent faculty. Actually, world-class universities are able to attract the most qualified professors and researchers around the world (Salmi, 2011). This has been described as a snowball process, where a renowned scholar gets funded to do cutting-edge investigation, attracting other colleagues and preeminent students, until a critical mass is formed in the field (Csikszentmihalyi, 1997). Similarly, world-class universities also tend to have a high rate of carefully chosen graduate students, closely involved in the research activities of these institutions. Nevertheless, these processes seem to not be major models in the Chilean and Latin American contexts for the educational research, although they can be developed as avant-garde policies at the national or institutional levels.

Other relevant dimensions are the general regulatory frameworks and the degrees of academic and managerial autonomy that universities have across and within societies. The Economist (2005) underscored that the higher education system in the United States is “the best in the world” mainly because of several factors, one of them being its capability to develop prolific, relevant and useful academic work for humanity. This report also highlighted that the positive environments in which these universities operate promote scientific investigation, critical
thinking, and innovation without major restrictions. Furthermore, institutions that operate under complete autonomy tend to be more dynamic because they are not tied to bulky bureaucracies and major external standards, even in the presence of accountability mechanisms.

In Chile, and Latin American in general, public universities are subjected to a good deal of bureaucratic restrictions, many of which are linked to budgetary issues, although private institutions usually enjoy a higher degree of autonomy from the State. However, other internal regulations and management practices may affect the ability of universities to produce research in collaborative ways. The globalization of economies and societies certainly has an impact across higher education systems. In the same way, higher education influences this process of globalization through its research and services. In Latin America, internationalization is recognized as an important phenomenon that is affecting the flow and platforms of knowledge, as well as societies in general.

There is evidence from Latin America that suggests that one of the best strategies for gaining cutting edge knowledge is to participate in the exchange of people and ideas. For Latin American countries, the challenge is to provide enquiry activities and job opportunities for talented and collaborative individuals to ensure a sufficient amount of advanced research and skills to their national and global economies (Holm-Nielsen et al., 2005).

It is important to underline that scholarly globalization implies that participants are linked to the principles of the fields and disciplines that are commonly shaped by the worldwide leading actors of research, mostly located in the foremost higher education institutions in the United States and other Western nations. Frameworks and methodologies used in funded research and published in important ISI-indexed journals tend to rule the intellectual world. Nonetheless, the topics and subjects of interest to leading scholars and institutions may not be completely known to universities at the periphery of knowledge networks. Thus, involvement in global research implies, in general, attachment to established research models and areas.

For the Chilean case, the influence of international knowledge through collaborative links seems to be diverse, coming from all the continents around the world, although upon closer examination these links come mostly from three nations: the United States, Spain and England. The collaboration with these countries is more intense than collaborative efforts with Latin American nations. This certainly has an impact across Latin American societies. Even more, it calls the attention the infrequent or null collaboration of Chile with countries it admires because of their outcomes in international tests and remarkable policies for improving the quality of their
educational systems, such as Finland, South Korea and Singapore, just for mention some of them. Accordingly, a more varied and mixed collaboration with other nations across the world should be balanced with the relevant and historical association with the major western countries of the globe.

Time is also a relevant factor that should be considered as part of the strategic plans and policies of research-oriented university systems. Governments are regularly under pressure to showcase immediate results. The common risk lies in taking impulsive decisions and ignoring the fact that the formation of a robust research university is not a short-term process. For example, hiring big name foreign researchers without matching them with a critical mass of national scholars may be an inappropriate policy (Salmi, 2011). As well, it is pertinent to emphasize that research higher education institutions–even world-class universities–probably cannot excel in all fields and disciplines.

Finally, the development of both research-oriented and collaborative universities requires, above all, strong leadership roles at all levels (country, university, and scholar levels). Studies on university leadership assert that top research universities have leaders who balance strong managerial abilities and successful research capabilities (Goodall, 2006).

Around the world, the highest-ranked colleges and universities are the ones that, among other outcomes, develop important contribution to the expansion of knowledge through research. These universities are an important benchmark, but it is important to note that there is no general formula for developing a world-class or research-oriented university. Local frameworks and institutional schemes vary extensively. Thus, each nation, institution and scholar should select, from among a wide range of possible pathways of collaboration and leadership, strategies and policies that leverage their respective strengths, resources, and skills. Moreover, the restructuring of tertiary educational actors cannot take place in isolation, and should depend on how higher education institutions choose to define themselves.

Challenges and opportunities

Nowadays, Latin American countries face several challenges and also opportunities to consolidate their scientific policies. For example, increasing the visibility and accessibility of high-quality Latin American educational papers may be supported by their inclusion into Open Access information systems and databases, but recognizing that ISI-indexed publications are more appreciated by the academic world, mainly because these publications go through rigorous peer-review processes.
In this regard, some non-English speaking countries have created journals in English as a way to expand the international visibility of their studies in several fields (Ren & Rousseau, 2004; Russell, 1998). Since Chile does not have a journal in education with these characteristics, the natural inclination for researchers is to publish abroad. It is not clear if the current dissemination of Chilean research and knowledge is appropriate. However, giving the amount of graduate students and scholars studying and working abroad that have to return to Chile (due to scholarship regulations), it seems reasonable to develop a journal that, in the long term, will be internationally recognized, becoming an option for national and international scholars, and increasing the potential amount, quality and impact of the research coming from Chile and Latin American, in general.

Studying a collaborative research network, Schwartz and his colleagues (2016) suggest some opportunities and recommendations for the further development and spread of research networks, such as increasing the development of faculty, bringing in essential resources, studying networks themselves, and promoting networks of networks. Additionally, and according to Casas (2001), the design of regional programs should take into account the transformation of infrastructural, scientific and technological capacities and the reinforcement of research networks sufficiently capable of including multiple levels of participation. In general, scientific communities in Latin America are limited by problems sustained by institutional and scientific policies (Acevedo, 2003). Thus, developing and consolidating research communities are one of the crucial challenges within and across Latin American nations. In fact, and according to Yin (1981), some case studies have determined that interpersonal relationships are key pieces of networking systems. Others have found that national and international associations and groups could replace interpersonal interactions. In general, studies in this field have recognized the relevance of early networking activities, even when such actions were apparently not focused on particular issues.

In this regard, at all levels, several organizations seem to play different roles for interconnecting actors based on research in the educational field. For instance, at the world level, UNESCO (United Nations Educational, Scientific and Cultural Organization) may be considered the main organization that promotes collaboration across nations around educational research. At the Latin American and Hispanic American level, OAS (Organization of American States), CELAC (Comunidad de Estados Latinoamericanos y Caribeños), and OEI (Organización de Estados Iberoamericanos) group countries from the mentioned regions that promoted the integration and development of their members. Especially for the latter, education as a whole and
educational research are key aspects of their missions. All of these organizations have periodic meetings, and sporadically gather Latin American scholars from the educational field.

The World Bank and IDB (Inter-American Development Bank) seem to be wealthier organizations, supporting long-term projects. In 2010, Chile became the first South American nation to become a member of the OECD (Organisation for Economic Co-operation and Development). For Latin America, and especially for Chile, these three organizations have had a major impact on educational research, providing monetary resources, datasets, reports and benchmarking for the analysis of educational researchers.

At the scholarly level, organizations such as Fulbright-IIE (www.iie.org/fulbright) in the United States, Red Carolina in Spain (www.fundacioncarolina.es/red-carolina/), and the British Council in the United Kingdom (www.britishcouncil.org) promote students and scholars exchange with several countries, including Chile and other Latin American nations. To some extent, these organizations may explain the high collaboration between Chile and these nations in terms of educational research.

At the country level, some organizations group together different universities based on their features. In the case of Chile, G9Red is a group of all Catholic universities, as well as UDEC and UTFSM, which was established to become a national leader in the creation of public goods that contribute to social, cultural and economic progress of the country (www.redg9.cl). All G9Red members are private institutions. On the other hand, CUE (http://uestatales.cl/cue) leads the coordination and collaboration of all the 16 public universities in Chile. Even though these two organizations do not condition members’ work with other universities, they seem to align the similar realities of their members, which may have some influence in the shared interests for educational research.

More informal networks, including Red INCHE (http://www.redinche.org/) in Spain, Red ICE in the UK, (http://investigadoreschilenoseneducacion.wordpress.com/), and RIECH in the United States (www.riech.cl), were initiated mainly by graduate students in education, and have tried to apply the basic principles of networking: connecting people with common and shared goals.

III. Recommendations and Future Research

Overall, the role and influence of formal and informal networks appear to be limited by political and financial issues. Thus, their specific roles may need to be evaluated in further research. Anyway, their presence seems to be good news for the future of educational research.
Thus, and taking into account the results of this study and others, it seems that most recommendations can be framed around two main issues: funding and leadership. In addition, future research based on the main aspects of this study are suggested in order to develop effective collaboration and leadership in the longer run.

**Funding and monetary issues**

According to Salmi (2011), a large quantity of resources is a component that characterize almost every world-class university. Usually, these universities draw from the following sources of financing: government budget funding to address operational costs and research, sponsored research from public and private organizations, financial revenues generated by donations and awards, and tuition fees. Overall, these financial resources generates a virtuous circle that allows to these universities to attract more specialized academics and scholars.

In this regard, some smaller developing countries may be deprived of the financial resources necessary to establish research universities. In such cases, it may be preferable to develop a regional research university. Information communication technologies (ICT) make these ventures more realistically achievable, and specific regions make them easier to implement than others. For example, Central America is a relatively limited area where a group of small countries share a common language, along with similar economic and social needs (Altbach, 2007).

Wealthier and larger than their counterparts in the Southern hemisphere of the planet, the long-established scholarly communities of the North hold resources that enable them to preserve leadership in the academic world. Universities in the North usually have close relationships with multinational companies and other consumers of research, which provides further funding sources for investigation (Altbach, 2011). In this regard, Chilean and Latin American educational research may be supported by foreign funding. Actually, this point was corroborated in a recent study of Queupil and Munoz (2016), detecting some Chilean educational research supported by funding from MICROSOFT and HP (especially for education and computer science projects), but also by national funding initiatives, such as CONICYT, FONDECYT and FONIDE.

Furthermore, for many developing countries, their participation in international conferences, symposiums and programs, along with their access to academic collaboration, is also dependent on external support from the North Western countries. Furthermore, Latin American institutions and scholars also look to larger and wealthier nations to validate their academic quality. For instance, researchers are encouraged to publish in prestigious Northern academic
journals, and in some cases, promotions are based on such kinds of publication. Even where local scholarly publication is found, many academic, institutional and policy decision-makers do not consider them of an appropriate quality (Altbach, 2011).

Probably related to centrality and peripherality is dependency. Latin American scholars often acknowledge that they are largely dependent on the principal hubs of knowledge in the global academic networks. The ample disparities and imbalances in access to economic resources and institutional infrastructure conduce to dependency (Altbach, 2011). Consequently, academic collaborations in Latin America operates in a world of dependency and peripherality, but at the same time they are profoundly enclosed in specific national realities.

In general, co-authorship networks continuously expand by the addition of new actors to the system. In the Chilean case, it seems that this network is a novel one, where some public policies are supporting the developing of new scholars, and subsequently new authors. Therefore, the properties of these networks are influenced by grants, awards, scholarships, and other financial support models for the development of human capital. In this regard, policies such as Beca Presidente de la República and Becas Chile have been important national strategies to increase the quantity and quality of researchers. Since the majority of these sponsored future scholars are studying abroad at prestigious universities, the issues that arise often concern their return to Chile, mainly because it is unclear whether the country has the capacity (i.e., job opportunities) to receive several waves of highly qualified scholars (Rovira & Carmona, 2015).

In addition, public funding for educational research should take into account collaborative efforts, such as co-authored articles. They require clear evaluation criteria of merit of some partnerships over others, regardless of ideologies, economics or socio-political context. Public funds should also support the research of junior scholars (especially those located outside Santiago, the capital city), in order to facilitate their immersion into collaborative networks. This point is important for Chile, since most competitive funding research and scholarships consider the educational field as a “priority area” for the country (OECD & World Bank, 2010).

Accordingly, public funding should be administered judiciously and in accordance with the needs of local and global settings. Internal university research funding systems should follow a similar format.

Therefore, it seems improbable that world-class or research-oriented universities can be quickly developed without positive policy setting and direct public leadership and support, just taking into account the high cost and resources required in building cutting-edge research facilities, capacities, and skills. Probably connected with this point, it is important to mention that
the Chilean government has recently approved the creation of a Ministry of Science and Technology (www.gob.cl/ministry-of-science-and-technology-key-aspects-of-the-bill). Although this enactment has been expected for decades for the academic community, it is not clear if this strategy will facilitate the process of research, especially aspects related to public funding support and international relations, or if this will become more bureaucratic and complex.

In this regard, investing financial resources without an appropriate governance and policy framework probably will be difficult. The case of Brazil may illustrate this point. The ability of top Brazilian public universities to administer their resources is controlled by rigid civil service protocols, despite the fact that these universities are the wealthiest ones in Latin America. Along with this, doctoral dissertations in languages other than Portuguese are forbidden, and foreign professors cannot be hired, by law, at least in public universities in Sao Paulo (Salmi, 2011). After all, top Brazilian universities have, proportionally, few linkages with the international research community. Many of these issues can be considered as the result of a deficient long-term strategic vision at the country and state government levels, affecting adversely university collaboration and leadership.

In sum, direct funding for research and doctoral programs has been central for fostering more and better research. Additionally, the international dimension is certainly important in defining an outline of leading institutions. This enables universities to enroll the most talented individuals from several parts of the world, and be positively exposed to different ideas and approaches. For example, the US universities that regularly rank at the top of the international rankings typically exhibit high rates of international academic labor force. Arguably, “the world’s best universities attract and employ large numbers of foreign students and faculty in their search for the most talented” (Salmi, 2011, p. 230).

Even though developing countries universities seem to be less attractive than their counterparts in the Northern hemisphere, an exchange of scholars, internships or similar mechanisms to enroll foreign graduate students and scholars may improve the international dimension of most higher education institutions located in Latin American and Chile.

*Development and role of leading educational actors*

According to Salmi (2011), there is an insufficient number of recognized world-class universities in developing countries, and the future is not optimistic in this matter. Several great Latin American public universities—in Brazil, Mexico, and Argentina—have world-class
potential. In this regard, it is more plausible to focus on research-oriented universities, which are most relevant for most developing or middle-income countries in Latin America.

*Flagship* is a term regularly used in the debate about research universities. This generally refers to a leading university in a country or tertiary education system. These universities are the institutions considered for influence and emulation. Thus, the flagship is typically the most prestigious university, almost always public, and probably among the largest in the nation, usually looked for leadership in higher education systems (Altbach, 2007).

According to Altbach (2007), the leading universities in developing countries are a central aspect in social and economic development. Mexico, Brazil, Argentina and probably other countries within Latin America have universities that, across time, have positioned as leading academic institutions and have had an important role, educationally, intellectually, and often politically, for their nations. Flagship institutions are always among the leading research universities in their countries, seeking to depict themselves as world-class in a regional or international context.

Research universities within developing countries usually engage in fields of study that are affordable and related to local priorities and needs. The humanities and social sciences are frequently ignored because the hard sciences are usually considered more financially solvent and respected. Yet the social sciences and humanities are central for the understanding of knowledge and society, and they tend to be considerably cheaper than the hard sciences. Thus, in the last decades, Chilean education has become a “priority area” for public funding and reform, mainly because major educational issues are in the spotlight for policymakers, researchers and universities. These circumstances are proper opportunities for these actors to display collaboration and leadership roles.

Providing more and appropriate leaders depends on a pertinent detection of them and on some leadership preparation. Moreover, effective higher education leadership also requires better public policies that give individuals in leadership positions the freedom to make a wide range of decisions, the support when the inevitable resistance against changes arise, and the resources needed to implement new procedures, plans or policies (Johnstone, 2011). Leadership network maps may support these tasks.

In other words, potential leaders should be empowered in order to become effective leaders. Based on the analysis of Johnstone (2011), if effective leadership is assumed to be the capacity to effect change, and if every needed change in higher education is challenged by some factions, then more effective leadership in universities and other higher education institutions in
developing countries should be developed. Collaborative networks seem to highlight the actors and patterns that are effecting change—in this case through coauthored articles. According to Johnstone (2011), there are several interrelated historical factors that frame the context of the leadership challenge in developing countries within scholarly communities.

Firstly, there are two paradoxical situations that still exist in most Latin American countries. On one hand, there is a persistent overemphasis on the research university structure. On the other hand, there is a weak academic labor force to support most institutions striving to become research universities. This is mainly due to the brain drain phenomenon, losing scholars that prefer to work in universities in Europe and the United States, depriving local universities of important resources, especially leadership and academic talent, which inhibits their progress and development.

A second factor is the tenacious financial austerity of universities in most Latin American countries. In addition, there is a disproportionate dependence on the limited public funds, which is aggravated by the enforced competition for restricted public revenues.

A third contextual factor in many developing nations is the government itself. Especially for public universities, governmental controls and regulations on spending, resource allocation, and other institutional decisions frequently interfere with the performance of universities and colleges, affecting and challenging the development of institutional and scholarly leadership.

Last but not least, a common factor in virtually all universities around the world, but especially in the developing country context, is their inherent traditionalism and conservatism as institutions. These aspects are likely to be the most difficult to change. Universities everywhere are purposefully designed to resist disruptions from cultural trends, political inclinations, or the changing needs of the economy. Moreover, faculty are resistant to supervision, control or demands for accountability, all of which are becoming obstacles that inhibit a change in the orthodox ways of working within universities.

In short, and taking into account the mentioned factors and other limitations, it seems that changes and improvements regarding higher education contexts are crucial, especially in Latin America. Given the mentioned status-quo, the ability to effect purposeful change (that is, the essence of leadership), mainly expressed in collaborative works, is challenging in all universities, especially under the circumstances of financial restraint and political instability that strikes many Latin American nations (Johnstone, 2011).

On the more positive side, based on the analysis of the evolution of collaborative works, the results of this study indicate that Chilean scholars in the educational field tend to work in
smaller groups and publish papers with fewer co-authors. In addition, it is pertinent to emphasize that the collaboration network is distributed into many clusters.

In this regard, and according to Barabási and his colleagues (2002), in most collaborative research networks, all authors are part of a distinctive large cluster from the very initial stages of the field, and a very small proportion of scholars do not collaborate at all. The Chilean case seems to have dissimilar features, probably because demographic conditions do not allow for scholars to make enduring connections across the country, but also because at the early stage the network had few actors, which did not allow any kind of clustering.

Nevertheless, in the short-term this situation should improve, taking into account the progress of the network since 2000. With time, the number of nodes in the co-authorship network will increase due to the arrival of new scholars. The total number of links also will increase through the connections made by new researchers with old ones and by new connections between old authors and between new actors. This situation is expected to occur due to public policies such as *Becas Chile* and because education has become a “priority area” for public agencies in charge of research funding. In addition, this study has showed the development of leadership roles within clusters that represent subdisciplines in the educational field, especially since 2000. Their role in the future should be crucial, taking into account the mentioned arrival of new scholars.

Despite the fact that leadership can be seen from the perspective of individuals, this study has showed the relevant social aspect of leadership through collaborative efforts. Thus, policies and training about scholars and institutional leadership roles may be outlined, in order to develop new and dynamic leaders in the educational research field. Thus, for instance, because getting a job could be a long and arduous process for new scholars, several policies may promote their participation and collaboration on several projects funded by public or private organizations.

More specifically, data seems to indicate that the most important funding organizations for educational research are CONICYT and FONDECYT (Queupil & Munoz, 2016). CONICYT, in particular, should take into account the amount of appearances for the same competitive funding in the same span of time, mainly because it is not reasonable, from the perspective of time, that a scholar be involved in too many projects. This could be complemented by guidelines regarding the inclusion of new scholars on ventures that request higher amounts of money, etc. With time, most prominent leaders may be chosen to serve as collaborative leaders on the basis of their previous research, partnerships, and scholar community, i.e., their potential to lead their fellow colleagues, where diversity of scholars should be also valued.
Finally, university research has a particular requirement for autonomy, and current claims for greater accountability of faculty are potentially problematic, especially for those most involved researchers. In general, scholars should have the autonomy to develop studies, since research typically begins from the concerns and interests of the faculty, in accordance with the national and international contexts and needs.

Under the mentioned conditions of financial austerity and the not uncommon political interference and instability found in many countries of Latin America, the challenges to higher education collaboration and leadership in the beginning of the twenty-first century seem to be fairly daunting.

However, opportunities for changes and improvements, especially in the practices and policies of tertiary education systems of the so-called developing countries, appear to be vast and varied. Universities and scholars in Chile, and in all nations in general, need to confront and overcome the ever-changing nature of the social sciences and the ever-shifting frontiers of knowledge itself, where collaboration and leadership may support a favorable setting for better outcomes.

Thus, in order to encourage and drive collaboration within educational research networks in Chile and Latin America, some initiatives should be based on developing operational research-oriented universities and highlighting the roles of university researchers’ leaders in that context. Regarding the last point, effective leadership in developing countries should be able to manage and conduct change through individual across institutions and/or national systems. Accordingly, leadership appears to be required for faculty that have been appointed, sponsored, stimulated, fostered, and retained by universities and academic programs.

Future research

According to Barabási and his colleagues (2002), research outcomes and procedures developed in the context of co-authorship networks could be useful for a methodical study of themselves and other dynamic evolving systems, such as social networks in the Internet and associations of scholars or universities. Thus, the replication of this type of study in other contexts and a subsequent comparison could be a reasonable suggestion for future work, especially if the focus of the analysis is the evolution of the network over several spans of time.

In addition, other areas of research appear to be relevant. For example, SNA techniques can describe and map several nodes and actors, such as publications, journals, major research areas, or grants in a research field of interest (e.g., Malin & Caley, 2007). Mapping journals
instead of authors provides a kind of disciplinary map. Additionally, they can identify interconnections, introductions and transfers of research across disciplines, the dynamics of a research field (e.g., diversification, specialization, speed of growth.), and the influence of strategic and implemented research funding programs. This examination is not only interesting for funding agencies, but also for research centers, educational institutions, researchers, and society as a whole.

Citation, co-citation, and inter-citation analysis also appear to be pertinent for the Latin American and Chilean context. These analyses are important in order to evaluate the impact of research by local scholars in the academic world within specific fields. The works of Andrews (2003) and Walter and Ribieri (2013) and White and McCain (1998) provide examples in this focus of analysis.

According to the results of the above articles, one would expect that citations be commonly made between papers on similar topics, which then might be corroborated for the Latin American and the Chilean cases. Mapping co-citation and inter-citation are, in turn, two approaches that evaluate interconnectedness, by examining linkages within and between (sub)disciplines, and detecting the most interdisciplinary areas of knowledge (Rorissa & Yuan, 2012).

The analysis of which authors are listed first on collaborative articles is another area that needs further research and analysis. Previous studies in information science have examined and contrasted three different approaches to designating citation credit: only the first author receives recognition, each author receives full credit, and rates are assigned to each co-author. It seems that citation credit should be conferred to co-author teams so that the cooperative success of co-authorship efforts can be studied (Börner, Dall’Asta, Ke & Vespignani, 2005). Nevertheless, it is important to be aware of the implicit relevance that scholars give to colleagues that are the first author of co-authored articles. Accordingly, research regarding this topic can be developed in order to detect patterns and roles of author statuses within and among collaborative educational articles. Similarly, the analysis of mentor/mentee and advisor/advisee relationships may be pertinent in collaborative works. However, since this information is not usually retrieved from datasets, this could be part of qualitative studies.

Following the frameworks of studies such as Zhou, Zhong, and Yu (2013) that assessed collaboration between China and the UK, it might be interesting to complete a bibliometric analysis to examine the relationship with the countries with more associations, partnerships, collaboration or other kind of interactions. According to Rorissa and Yuan (2012), information
retrieval is also a way to evaluate intensive interactions overseas and visualize the intellectual structures of a field. The work of Li and his colleagues (2015) presents an interesting methodology in this regard. Thus, for the Chilean case, the analysis of the collaboration and intercitation with the United States, England, or Spain seems to be the most remarkable examples for examination.

Semantic web and semantic network analyses are additional methods for examining patterns of research, in order to improve knowledge management, mainly because there is an increasing amount of data and platforms in the World Wide Web that group and integrate several notions, concepts, and ideas from different individuals and fields (Börner, 2006; Sowa & Borgida, 1991). The works of Henrique and his colleagues (2014) and Xia and Bu (2012) may enlighten future works in this area for the educational field.

Although this study is not a tool to evaluate scholars or institution performance, one should be aware that several accountability policies encourage an academic professional as an academic ladder. Those principles enable talented professors and scholars to be promoted up the ranks of the academic profession, based on their performance, productivity, and the quality of their work.

This study seems to indicate that this point is relevant for the Chilean case, since most detected scholars with leadership roles have eventually achieved an appointment as department heads, chairs of a journal, or high academic positions within their universities. Most interestingly, collaborative efforts seem to be a relevant in this matter for the educational field, taking into account the case of scholar QP, who coauthored all their articles.

Therefore, mapping coauthored educational research and authors’ expertise or career trajectories, based on their personal bibliography files, may be a novel way of examining the evolution of researchers’ roles. The work of Murray and his colleagues (2006) presents an interesting technique regarding the mentioned approach, which can be applied to the educational field in several contexts.

Within gender issues studies, the involvement of women in research professions varies and differs across countries. In many Latin American nations, the percentage of women holding academic positions is relatively high –often higher than in industrialized countries. For example, in the early 1990’s, more than one-third of academics in Brazil, Mexico and Chile were women (Boyer, Altbach & Whitelaw, 1994). Nevertheless, this is a topic that deserves more updated studies, especially an analysis by gender across different research fields, where the field of educational research could provide interesting results.
The importance of context seems to be relevant for this kind of study, mainly because the characteristics visualized within specific settings may vary a lot. In this regard, other research strategies and methodologies can complement the insights from cases studies, such as different kinds of qualitative studies on leadership in collaborative networks.

For example, using data and results of this and other studies, qualitative studies may purposefully select units for comparative ethnographic studies to determine practices and behaviors that promote, maintain, or inhibit collaboration and leadership roles. Qualitative studies should take into account that some people, due to their interpersonal skills, may be more effective leaders than others. As well, most individuals in leadership positions and roles can learn to be better leaders.

According to Johnstone (2011), the most effective higher education leadership would feature, among other skills, the ability to influence faculty to effect the desired changes. In addition, they should be able to choose strong administrative or academic teams, give guidance and then delegate tasks to these teams, and make modifications to teams when necessary. Additionally, academic leaders should be able to communicate effectively to faculty and (under)graduate students—and in other spheres, to civic leaders, policy-makers and politicians. Some of these skills are attributes that can be learned or improved through mentoring and training, a component that also should be addressed in further qualitative studies.

This study aims to provide a better understanding of collaboration and leadership in large-scale networks, using SNA techniques for the visualization of collaborative environments among researchers in the Chilean context. The results of this kind of study may be useful and interesting for policymakers, institutions researchers, educators, and practitioners involved in the promotion and development of more and better collaboration and leadership among higher education institutions that investigate educational topics.

In summary, for the Chilean case, collaboration through co-authorship is a reasonable way to intensify the quantity and quality of papers in the educational field. In fact, this study reveals a perceptible upward trend in collaborative research, based on the results of coauthored efforts reported in major ISI-indexed journals.

The nature, dynamism and other characteristics of collaboration and leadership within the educational research have been detected. Thus, the findings of this study can be helpful in research planning and for the improvement of policies at the institutional and country levels. They may support the accomplishment of a more efficient and effective organization and management of information resources and services among the actors that develop educational
research in the Chilean context, which in turn assists the evolvement of leaders that facilitate multi-authored research activities.

Thus, this study helps to identify strategies for increasing more participation, collaboration, and leadership within groups and networks, based on policies that promote close collaboration, both public and private funding, and rewards and incentives for the development of collaborative research.


Mehra, A., Dixon, A., Brass, D., & Robertson, B. (2006). The social network ties of
groupleaders: Implications for group performance and leader reputation. *Organization
Science, 17*(1), 64–79.

Mehra, A., Kilduff, M., & Brass, D.J. (2001). The social networks of high and low self-monitors:


improvement*. Aurora, Co: Author.

networks in urban situations: analyses of personal relationships in Central African towns.*
Manchester, England: Manchester University Press.

Administración Pública, 1*(2), 69-77.

Moolenaar, N. M. (2012). A social network perspective on teacher collaboration in schools:

Moolenaar, N. M., Sleegers, P.J.C., Karsten S., & Daly, A. J. (2012). The Social Fabric of

Moreno, J. L. (1934). *Who shall survive?: A new approach to the problem of human

Education*. Dordrecht: Springer.


on personal bibliography files. *Tenth International Conference on Information
Visualisation (IV’06)*. IEEE; 2006:258-263.


National Academy of Sciences, 98*(2), 404-409.

Review E, 64*(2), 1-4.


Collaborative Communities: Schools, University, and Community Organizations.
Information Age Publishing.


Appendix A

Countries collaborating with Chile in Educational Research

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of appearances</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>44</td>
</tr>
<tr>
<td>Spain</td>
<td>44</td>
</tr>
<tr>
<td>England</td>
<td>13</td>
</tr>
<tr>
<td>Germany</td>
<td>6</td>
</tr>
<tr>
<td>Italy</td>
<td>6</td>
</tr>
<tr>
<td>Australia</td>
<td>6</td>
</tr>
<tr>
<td>Argentina</td>
<td>5</td>
</tr>
<tr>
<td>Brazil</td>
<td>4</td>
</tr>
<tr>
<td>Colombia</td>
<td>4</td>
</tr>
<tr>
<td>Mexico</td>
<td>4</td>
</tr>
<tr>
<td>Canada</td>
<td>4</td>
</tr>
<tr>
<td>India</td>
<td>3</td>
</tr>
<tr>
<td>Belgium</td>
<td>2</td>
</tr>
<tr>
<td>France</td>
<td>2</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>2</td>
</tr>
<tr>
<td>Japan</td>
<td>2</td>
</tr>
<tr>
<td>Netherlands</td>
<td>2</td>
</tr>
<tr>
<td>China</td>
<td>2</td>
</tr>
<tr>
<td>Portugal</td>
<td>2</td>
</tr>
<tr>
<td>Sweden</td>
<td>2</td>
</tr>
<tr>
<td>Cuba</td>
<td>1</td>
</tr>
<tr>
<td>Denmark</td>
<td>1</td>
</tr>
<tr>
<td>Finland</td>
<td>1</td>
</tr>
<tr>
<td>Greece</td>
<td>1</td>
</tr>
<tr>
<td>Iceland</td>
<td>1</td>
</tr>
<tr>
<td>Israel</td>
<td>1</td>
</tr>
<tr>
<td>Lithuania</td>
<td>1</td>
</tr>
<tr>
<td>Norway</td>
<td>1</td>
</tr>
<tr>
<td>Romania</td>
<td>1</td>
</tr>
<tr>
<td>Russia</td>
<td>1</td>
</tr>
<tr>
<td>Serbia</td>
<td>1</td>
</tr>
<tr>
<td>Switzerland</td>
<td>1</td>
</tr>
<tr>
<td>South Africa</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>172</strong></td>
</tr>
</tbody>
</table>
# Appendix B

## Chilean Institutions in the Collaborative Network

<table>
<thead>
<tr>
<th>Institution Name</th>
<th>Acronym</th>
<th>Type of Institution</th>
<th>Foundation (year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pontifical Catholic University</td>
<td>PUC</td>
<td>University (private)</td>
<td>1888</td>
</tr>
<tr>
<td>University of Chile</td>
<td>UCH</td>
<td>University (public)</td>
<td>1842</td>
</tr>
<tr>
<td>Pontifical Catholic University of Valparaiso</td>
<td>PUCV</td>
<td>University (private)</td>
<td>1925</td>
</tr>
<tr>
<td>University Diego Portales</td>
<td>UDP</td>
<td>University (private)</td>
<td>1982</td>
</tr>
<tr>
<td>University of Santiago</td>
<td>USACH</td>
<td>University (public)</td>
<td>1849</td>
</tr>
<tr>
<td>University of La Frontera</td>
<td>UFRO</td>
<td>University (public)</td>
<td>1981</td>
</tr>
<tr>
<td>Interdisciplinary Program in Educational Research</td>
<td>PIIE</td>
<td>Research Center</td>
<td>1971</td>
</tr>
<tr>
<td>University of Concepcion</td>
<td>UDEC</td>
<td>University (private)</td>
<td>1919</td>
</tr>
<tr>
<td>University Alberto Hurtado</td>
<td>UAH</td>
<td>University (private)</td>
<td>1997</td>
</tr>
<tr>
<td>University Adolfo Ibarra</td>
<td>UAI</td>
<td>University (private)</td>
<td>1953</td>
</tr>
<tr>
<td>Catholic University Santisima Concepcion</td>
<td>UCSC</td>
<td>University (private)</td>
<td>1991</td>
</tr>
<tr>
<td>University Andres Bello</td>
<td>UNAB</td>
<td>University (private)</td>
<td>1988</td>
</tr>
<tr>
<td>Technical University Federico Santa Maria</td>
<td>UTFSM</td>
<td>University (private)</td>
<td>1929</td>
</tr>
<tr>
<td>University Austral</td>
<td>UAUSTRAL</td>
<td>University (private)</td>
<td>1954</td>
</tr>
<tr>
<td>University of Los Andes</td>
<td>UANDES</td>
<td>University (private)</td>
<td>1989</td>
</tr>
<tr>
<td>Central University</td>
<td>UCENTRAL</td>
<td>University (private)</td>
<td>1982</td>
</tr>
<tr>
<td>Catholic University of the Maule</td>
<td>UCMAULE</td>
<td>University (private)</td>
<td>1991</td>
</tr>
<tr>
<td>Catholic University of the North</td>
<td>UCN</td>
<td>University (private)</td>
<td>1956</td>
</tr>
<tr>
<td>Catholic University of Temuco</td>
<td>UCTEMUCO</td>
<td>University (private)</td>
<td>1991</td>
</tr>
<tr>
<td>University of Talca</td>
<td>UTAL</td>
<td>University (public)</td>
<td>1981</td>
</tr>
<tr>
<td>University of Valparaiso</td>
<td>UV</td>
<td>University (public)</td>
<td>1981</td>
</tr>
<tr>
<td>Technological University</td>
<td>INACAP</td>
<td>University (private)</td>
<td>1966</td>
</tr>
<tr>
<td>Academy of Christian Humanism University</td>
<td>UAHC</td>
<td>University (private)</td>
<td>1975</td>
</tr>
<tr>
<td>University of the Bio Bio</td>
<td>UBB</td>
<td>University (public)</td>
<td>1947</td>
</tr>
<tr>
<td>University Desarrollo</td>
<td>UDD</td>
<td>University (private)</td>
<td>1990</td>
</tr>
<tr>
<td>Ministry of Education of Chile</td>
<td>MINEDUC</td>
<td>Government</td>
<td>1837</td>
</tr>
<tr>
<td>University San Sebastian</td>
<td>USS</td>
<td>University (private)</td>
<td>1989</td>
</tr>
<tr>
<td>University Santo Tomas</td>
<td>UST</td>
<td>University (private)</td>
<td>1988</td>
</tr>
<tr>
<td>University of La Serena</td>
<td>ULASERENA</td>
<td>University (public)</td>
<td>1981</td>
</tr>
<tr>
<td>Playa Ancha University of Educational Sciences</td>
<td>UPLA</td>
<td>University (public)</td>
<td>1948</td>
</tr>
<tr>
<td>Institution Name</td>
<td>Abbreviation</td>
<td>Type</td>
<td>Year</td>
</tr>
<tr>
<td>------------------------------------------------------------</td>
<td>--------------</td>
<td>-------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Central Bank of Chile</td>
<td>BANCOCENTRAL</td>
<td>Public-autonomous</td>
<td>1925</td>
</tr>
<tr>
<td>Arturo Prat University</td>
<td>UAP</td>
<td>University (public)</td>
<td>1984</td>
</tr>
<tr>
<td>Chilean-Britannic University of Culture</td>
<td>UCHBRIT</td>
<td>University (private)</td>
<td>2005</td>
</tr>
<tr>
<td>Metropolitan University of Educational Sciences</td>
<td>UMCE</td>
<td>University (public)</td>
<td>1981</td>
</tr>
<tr>
<td>University of Tarapaca</td>
<td>UTAR</td>
<td>University (public)</td>
<td>1981</td>
</tr>
<tr>
<td>Metropolitan University of Technology</td>
<td>UTEM</td>
<td>University (public)</td>
<td>1993</td>
</tr>
<tr>
<td>National Council of Television</td>
<td>CNTV</td>
<td>Public-autonomous</td>
<td>1970</td>
</tr>
<tr>
<td>School (K-12)</td>
<td>SCHOOL</td>
<td>K-12</td>
<td>-</td>
</tr>
<tr>
<td>University of Antofagasta</td>
<td>UANTOF</td>
<td>University (public)</td>
<td>1981</td>
</tr>
<tr>
<td>University of Atacama</td>
<td>UATACAMA</td>
<td>University (public)</td>
<td>1981</td>
</tr>
<tr>
<td>University Autonoma</td>
<td>UATONOMA</td>
<td></td>
<td>1989</td>
</tr>
<tr>
<td>University of Los Lagos</td>
<td>ULAGOS</td>
<td>University (public)</td>
<td>1993</td>
</tr>
<tr>
<td>University of Magallanes</td>
<td>UMAG</td>
<td>University (public)</td>
<td>1961</td>
</tr>
<tr>
<td>University for the Arts, Sciences, and Communication</td>
<td>UNIACC</td>
<td>University (private)</td>
<td>1981</td>
</tr>
<tr>
<td>University of the Pacific</td>
<td>UPACIFICO</td>
<td>University (private)</td>
<td>1990</td>
</tr>
</tbody>
</table>
Appendix C

Identification of authors based on number of appearances before and since 2000

<table>
<thead>
<tr>
<th>Number of appearances</th>
<th>Before 2000</th>
<th>Since 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Author identification</td>
<td>N</td>
</tr>
<tr>
<td>2</td>
<td>BO, HN, NV, OT</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>HH</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>FJ, NM, PP, SD, TS</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>CC, UX</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>KS</td>
</tr>
<tr>
<td>15</td>
<td>VK</td>
<td>1</td>
</tr>
<tr>
<td>38</td>
<td>0</td>
<td>QP</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>83</td>
<td>635</td>
</tr>
</tbody>
</table>

(*) The 506 authors who appeared just once since 2000 can be determined as the counterpart of the authors mentioned in the other rows, such as A, C, D, E, G, H, I, L, M, O, P, S, T, U, X, Y, AA, AD, etc.
## Appendix D

**Scholars of each cluster within the Collaborative Network since 2000**

<table>
<thead>
<tr>
<th>Number of scholars within cluster</th>
<th>Number of clusters</th>
<th>Author(s) of each cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23</td>
<td>BE, BW, CC, CL, CU, DX, FO, GS, HA, IB, ID, JQ, KT, OC, OV, RE, RF, SJ, TE, VC, VF, VG, XX.</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>G83(XQ, ZW); G84(QS, AAE); G85(OL, WL); G86(AL, ES); G87(AW, RS); G88(PB, UZ); G89(KN, QM); G90(LA, OP); G91(BP, OG); G92(BN, KF); G93(BU, TO); G94(BV, GC); G95(VO, ZH); G96(LW, MB); G97(FV, GL); G98(QD, ZK); G99(PY, VN); G100(GT, JG); G101(ML, ND); G102(DB, GZ); G103(TP, UQ); G104(QF, UC); G105(IC, KP); G106(DH, YW); G107(MS, AAG); G108(IG, KH); G109(G, TN); G110(NZ, VH); G111(T, WJ); G112(EF, GX).</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>G53(NP, QE, JR); G54(CY, JC, AJ); G55(AF, RB, AQ); G56(SP, UD, AP); G57(NE, QR, AZ); G58(GA, WD, AY); G59(KY, W, KE); G60(EL, QB, BA); G61(CS, VX, BC); G62(FK, FN, BL); G63(JW, OJ, BX); G64(IA, WM, CD); G65(RP, ZJ, DC); G66(TJ, XS, PW); G67(ZE, ZF, JM); G68(IL, SZ, U); G69(KQ, SG, V); G70(FU, FY, ED); G71(RK, UY, HZ); G72(TA, TU, GK); G73(CR, RN, S); G74(SO, YD, HW); G75(FW, RG, CX); G76(KM, LQ, H); G77(QZ, VL, E); G78(YS, TR, YT); G79(DD, JK, EM); G80(JE, DO, KA); G81(RR, AAD, ZZ); G82(JO, OI, KJ).</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>G35(RD, JH, EE, XI, U); G36(SH, XC, PM, OM); G37(UO, VE, GR, EP); G38(XD, XV, QQ, AS); G39(HE, ZS, BF, AU); G40(NG, NH, FN, AE); G41(QI, YE, IN, BJ); G42(JJ, VB, EN, CA); G43(LN, YM, HQ, FE); G44(QY, W, QI, EV); G45(LS, RT, HG, BG); G46(U, UE, YL, FR); G47(IM, TF, HU, CF); G48(NE, EI, MK, IY); G49(PK, WC, DP, CR); G50(JP, OF, ET, C); G51(RO, TX, PU, LT); G52(ZU, AAC, TT, CE).</td>
</tr>
<tr>
<td>5</td>
<td>11</td>
<td>G24(QT, SL, XJ, RA, AH); G25(BZ, FQ, YA, CQ, QV); G26(XF, NV, IV, TC, GQ); G27(XA, SE, XO, JD, XR); G28(SB, NJ, XI, MI, OQ); G29(YP, TK, PT, OY, QN); G30(CT, MI, OO, GV, CM); G31(AV, QH, WY, BT, AX); G32(PN, ZL, DZ, CI, BB); G33(TD, VS, R, JF, DG); G34(RZ, ZC, NN, HC, HB).</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>G19(LZ, VV, YH, YR, EI, MG); G20(PJ, SX, MQ, AA, XH, UB); G21(XM, YJ, UW, LI, GI, DK); G22(TV, UL, QK, OR, FB, DV); G23(PF, XN, LV, CB, AG, P).</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>G15(PQ, QC, TH, LI, OH, NK, GM); G16(RC, VI, ZN, SC, EU, UJ, WE); G17(UX, UP, PC, EQ, KK, UK, QU); G18(NT, UI, MT, ME, MD, LM, JT).</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>G13(WP, MZ, MR, VU, DE, QG, AI, FT); G14(QZ, ZV, YN, RM, JW, EK, BM, AD).</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>G11(UA, YX, ZD, XZ, HV, FC, AAA, PX, IT); G12(TW, XK, SQ, NX, XX, JU, DT, BY, BD).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>$G_7(\text{VJ, ZY, VA, TY, QW, PL, PA, NI, MC, HK, DM, CW})$; $G_8(\text{VD, NY, JZ, WW, PH, AO, PZ, WT, CN, KV, DW, ZR})$.</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>$G_6(\text{PP, WF, TI, ER, K, ZG, QO, EO, RW, GH, DQ, DJ, HJ, IH, WA})$.</td>
</tr>
<tr>
<td>19</td>
<td>1</td>
<td>$G_5(\text{WK, NQ, IL, WU, MW, FH, FA, PS, OX, HS, LB, UR, RX, FM, AN, AM, GY, BK, IX})$.</td>
</tr>
<tr>
<td>23</td>
<td>1</td>
<td>$G_4(\text{PG, KU, WG, ZX, WB, VR, QL, NC, MA, LX, KW, JY, EC, RV, SU, SW, QX, LY, KB, EJ, CP, BI, KI})$.</td>
</tr>
<tr>
<td>32</td>
<td>1</td>
<td>$G_2(\text{YF, YV, VT, VQ, VM, TZ, TQ, SY, SF, SA, PR, ON, OD, NS, NB, NA, MY, MU, MF, LU, LF, KC, JL, HY, GW, GF, GE, GB, FZ, CK, CJ, D})$.</td>
</tr>
</tbody>
</table>
VITA
Juan Pablo Queupil

Education
MBA, Universidad de Chile, 2007.
Industrial Engineer, Universidad de Chile, 2002.
B.S., Engineering, Universidad de Chile, 2000.

Professional Experience
Coordinator and Manager of Assessments and Testing Unit, Department of Evaluation, Measurement and Educational Record (DEMRE), Universidad de Chile, Santiago, Chile. (January 2004 – July 2012)
Head of Projects Section, Department of Evaluation, Measurement and Educational Record (DEMRE), Universidad de Chile, Santiago, Chile. (January 2003 – December 2003)

Fellowships, Honors and Awards
2013 Latin America Special Interest Group Travel Award. Comparative and International Education Society (CIES).
2010 Becas Chile Grant. CONICYT. Chile.
2002 Outstanding Student Recognition. Department of Industrial Engineering, Universidad de Chile.

Publications
2016 Queupil, J.P. & Muñoz, D.A. A Social Network Analysis of Educational Collaborative Efforts among Chilean Universities: Community Funding and School Involvement. In J. Slater, R. Ravid, & R. Reardon (Eds.), Building and Maintaining Collaborative Communities: Schools, University, and Community Organizations: Information Age Publishing.