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INTERNATIONAL ACADEMIC COOPERATION: DESCRIBE HOW AND WITH WHOM YOU COLLABORATE, AND I WILL TELL YOU WHAT KIND OF RELATIONSHIP YOU HAVE

COOPERAÇÃO ACADÊMICA INTERNACIONAL: DIGA-ME COMO E COM QUEM COOPERAS E TE DIREI QUE TIPO DE RELACIONAMENTO TENS

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ABSTRACT

This research aimed to describe the practices of international academic cooperation between researchers from top PPGs at state universities in Paraná and researchers abroad, as well as to map this network of relationships. This study is qualitative, descriptive, and ex post facto, with primary data collected through thirty-five (35) semi-structured interviews with professors. Secondary data included documents from the studied PPGs and the Lattes curricula of the 192 professors involved. The data were triangulated and analyzed using thematic content analysis. The most significant international experience for professors and their PPGs was training abroad. International academic cooperation practices are mainly based on individual efforts by professors to foster and develop partnerships initiated through personal contacts. When there is a need for financial, structural, material, or technological resources to advance research, cooperation tends to become formalized. When such resources are not needed, relationships often remain informal. Within the networks of relationships between researchers from the studied PPGs and abroad, very strong and deeply embedded ties (almost like family or close friends) and strong and embedded ties (co-workers and on-demand colleagues) were identified. No weak or arm-lenght' ties were observed.

Keywords: Cooperation. International. Relationship.

RESUMO

O objetivo desta pesquisa foi descrever as práticas de cooperação acadêmica internacional entre pesquisadores dos PPGs de excelência das universidades estaduais do Paraná e pesquisadores no exterior, bem como descrever esta rede de relacionamentos. Esta pesquisa caracteriza-se como qualitativa, descritiva, *ex-post-factum,* cujos dados primários foram coletados por meio de 35 entrevistas semiestruturadas com professores. Os dados secundários utilizados foram os documentos dos PPGs estudados e o lattes dos 192 professores destes PPGs. Os dados coletados foram triangulados e analisados por meio da análise de conteúdo temática. A experiência internacional mais importante para os professores e para seus PPGs foi a formação no exterior. As práticas de Cooperação Acadêmica Internacional estão pautadas no esforço individual dos docentes para alavancar e desenvolver parcerias iniciadas a partir de contatos. Quando há necessidade de recursos financeiros, estruturais, materiais e tecnológicos para desenvolvimento da pesquisa, a cooperação tende a ser formalizada. Quando não dependem destes elementos, tendem a manter-se informais. Nas redes de relacionamentos entre os pesquisadores dos PPGs estudados e no exterior foram identificados laços muito fortes e muito imersos (quase-parentes e superamigos) e laços fortes e imersos (colegas de trabalho e sob demanda). Não foram identificados laços fracos ou amplos.

Palavras-Chave: Cooperação. Internacional. Relacionamento.

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1 INTRODUCTION

Contemporary scientific knowledge increasingly results from collaborative efforts involving researchers from different countries, institutions, and fields of expertise. Such partnerships consistently produce richer and more impactful outcomes than individual efforts alone. Science is conducted globally (Sanderson, 2008; Oliveira, 2018).

Practices related to international academic cooperation (IAC) originate with researchers themselves (Sonenwald, 2012; Sanderson, 2008; Sundet, 2017; Leite; Pinho, 2016), who seek out others with similar research interests and share knowledge, methodologies, and results, forming research groups or networks that may or may not be connected to an institutional program.

Research on the internationalization of higher education institutions (HEIs) has often overlooked the key actors in this phenomenon (Sonenwald, 2007; Dewey; Duff, 2009; Childress, 2010; Sanderson, 2011; Biancani; Mcfarland, 2013; Finkelstein et al., 2013; Proctor, 2015; Romani-Dias et al., 2019; Neves et al., 2019). Although there are studies on research networks and their characteristics, these tend to focus on structural aspects such as network models, centrality, and dispersion, rather than on how these networks are initiated, developed, and energized, particularly through the individual and personal actions of researchers (Leite; Pinho, 2016; Lewis, 2010; Duarte et al., 2012; Romani-Dias et al., 2019).

Higher education institutions (HEIs) serve as catalysts by hosting and providing infrastructure for these actors, while faculty members establish cooperation agreements, either formally or informally (Carter, 1992; Morey, 2003; Chan, 2004; Sanderson, 2008; Duarte et al., 2012). However, cooperation still does not receive the attention it clearly deserves (Biancani; Mcfarland, 2013; Sundet, 2017; Leite; Pinho, 2016; Sutton, 2010, 2015; Lukkonen et al., 1992; Nyangau, 2018; Proctor, 2015; Moody, 2004).

Several international studies highlight the importance of faculty members as key to developing IAC and the internationalization of HEIs (Sutton, 2010, 2015; Sundet, 2015; Sonnenwald, 2007; Proctor, 2015; Sanderson, 2008; Rigby; Edler, 2005; Wasserman; Faust, 2007; Wagner; Leydessdorff, 2005; Wagner, 2004; Newman, 2001; Solla Price; Beaver, 1966). The individual level remains less explored and needs more understanding of how researchers contribute to internationalization both individually and through their networks, as well as how academic cooperation arises and grows among them (Sundet, 2017; Childress, 2010, 2009; Leite; Pinho, 2016).

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This study is based on the idea that strong and weak ties (Granovetter, 1973) among researchers and their social embeddedness (and reach) within the network (Uzzi, 1997) may enable various formal and informal IAC practices (Georgiou, 1998; Bozeman, Fay, and Slade, 2013). Faculty members of graduate programs (PPGs) who earned their degrees abroad tend to leverage their networks to establish scientific exchanges and partnerships, considered a key factor for the internationalization of both the PPGs and research in Brazil (Ramos, 2018). In other words, relationship networks support IAC.

This study aims to describe the international academic collaboration between researchers from leading PPGs at public universities in Paraná and their foreign counterparts, and to characterize this network of relationships.

2 THEORETICAL FRAMEWORK

This section introduces the main concepts that form the foundation of this research.

2.1 INTERNATIONAL ACADEMIC COOPERATION (IAC)

For this study, collaboration and cooperation are used interchangeably, as argued by Johnson and Johnson (1989), who claim there is no meaningful difference between the two terms. They suggest that trying to distinguish them offers little to no benefit and that such distinctions are hard to define in practice. IAC can be defined as the joint research and knowledge creation carried out by two or more scientists working in different countries who, through formal or informal connections, produce shared outcomes, specifically, practices of international academic cooperation (Georghiou, 1998; Sonnenwald, 2007; Sanderson, 2008). Much of the literature assumes that the most effective way to measure cooperation is through co-authorship on academic publications and the analysis of collaborative networks (Frame; Carpenter, 1979; Meadows, 1974; Newman, 2001). However, several authors (Katz; Martin, 1997; Bozeman; Dietz; Gaugham, 2001; Bozeman; Corley, 2004; Sonnenwald, 2007; Edge, 1979; Stokes; Harfley, 1989; Lewis et al., 2016) caution against equating co-authorship with cooperation, as it is only a partial indicator of collaborative activity. Academic cooperation is fundamentally a social activity rooted in relational networks (Lewis et al., 2016). The connections among researchers may be purely instrumental, serving as a short-term means to conduct research and publish, or they may develop into long-term friendships and

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partnerships based on shared intellectual interests (Lewis, 2010). This crucial distinction is often hidden in studies that define cooperation solely in terms of co-authorship.

Wagner and Leydesdorff (2005) acknowledge that many existing theories on the growth of international cooperation have merit, but they argue that these theories are insufficient to fully explain the phenomenon. These theories often only apply partially and tend to focus on large-scale projects, while most academic cooperation takes place on a smaller and less resource-intensive scale. IAC is an emergent, self-organizing system where the selection of partners and research locations depend on individual researchers' choices rather than institutional incentives. In IAC, there are no centralized authorities directing the organization of science; instead, it emerges spontaneously from the relationships among researchers, regardless of their geographical location.

2.1.2 Practices of International Academic Cooperation

Table 1 presents the main practices of International Academic Cooperation (IAC).

Table 1 Practices of International Academic Cooperation

AUTHOR	COOPERAÇÃO ACADÊMICA INTERNACIONAL
Crane (1972)	Collaboration between advisors and graduate students who work together on research and publish their findings.
Solla Price (1976)	Participation in congresses, conferences, meetings, and institutional exchange visits; cooperation in managing and administering research funds and laboratories.
Katz e Martin (1997)	Researcher exchanges, scholarships; workshops or other academic meetings; cooperative projects or research networks; shared costs/benefits of scientific instruments or large-scale facilities; long-term relationships between laboratories and/or subsidiaries in partner countries; participation in national and international cooperation programs; sponsorship or involvement in national research funding programs.
Stallivieri (2004)	Student, faculty, and administrator exchanges; participation in international research networks and groups; collaborative investigations with global reach; fundraising from national and international sources; coordination and participation in international congresses and seminars; involvement in meetings and councils convened by international organizations; scientific and academic cooperation agreements; joint academic degree programs; partnerships with world-renowned centers of excellence; training of highly skilled professionals; talent attraction; and dissemination of research results.
Sanches *et al.* (2016)	Participation of researchers in joint research projects with international colleagues; involvement in global events, meetings, and dissertation committees; development of international research expeditions and missions through collaborations between researchers from different countries; sandwich master's and doctoral programs; scholarships and exchange programs for undergraduate and graduate students; presentations at international events; scientific publications in international journals and conferences; visiting researchers and faculty in international graduate programs; internships and fellowship programs for students in foreign companies or institutions organizations.

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AUTHOR	COOPERAÇÃO ACADÊMICA INTERNACIONAL
Georghiou (1998)	**Formal cooperation**: established through contracts or agreements at national or institutional levels, involving legal documents, protocols, or cooperation treaties; **Informal cooperation:** occurs within the scope of specific projects led by researchers, with commitments established at the personal or institutional level and involving some form of international exchange. Informal cooperation can also precede more formalized relationships.
Lewis *et al.,* 2016	**Concrete cooperation:** researchers formally collaborate on a project from the start, jointly designing and executing it, and publishing the results together. **Expressive cooperation**: involves exchanging ideas, providing intellectual feedback, and commenting on research work.
Frame e Carpenter (1979); Meadows (1974); Newman (2001)	Co-authored publications.
CAPES / Field Document – Administration (2010 to 2012); Evaluations and Reports (2013)	Publications in international journals; co-authored papers with researchers from other countries; editorial roles in high-impact foreign journals; faculty or student publications at international conferences; research projects funded by scientific agencies; hosting or inviting visiting professors; peer review for international journals or conferences; co-supervision or joint supervision of theses with foreign institutions; membership on international editorial boards; student or faculty exchanges with international institutions; leadership or participation in international research groups or networks; involvement in international dissertation committees; engagement in research projects with scholars from different countries.

Source: Elaborated by the authors.

2.2 RELATIONSHIP NETWORKS AND INTERNATIONAL ACADEMIC COOPERATION

A relationship network consists of a set of ties or connections among actors, whether they are individuals or organizations (Martes et al., 2006; Granovetter and Swedberg, 2000; Scott, 2003; Wellman and Berkowitz, 1991). Relationships have both form (structure) and content. The form refers to all connections that actors maintain with others, outlining the network's design and indicating the number of connections. The content pertains to the nature of the relationship between two actors, including the flow of information, resources, advice, or friendship (Granovetter, 1973; Wasserman; Faust, 2007). This study focuses on the content of relationships, especially drawing on the works of Granovetter (1973, 1983) and Uzzi (1997).

According to Granovetter (1973, 1983), a relationship can be characterized by either a strong or weak tie. A strong tie is defined by frequent interactions that provide access to information and resources within the actors' social circles. These ties reflect a shared identity, reliance on references for decision-making, and are based on credibility and influence developed through intense and regular interactions (Granovetter, 1973, 1983, 1985). They tend to have a greater impact on decision-making and offer stronger support and assistance to group members (Granovetter, 1973, 1983, 1985). In contrast, a weak tie results from

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infrequent, short interactions (Granovetter, 1973, 1983). Such ties indicate more superficial relationships with contacts from different groups and provide access to information and resources beyond the actors' immediate social circles (Granovetter, 1973, 1985). Weak ties connect individuals across various groups and serve as bridges for the circulation of innovations (Granovetter, 1973, 1983).

According to Uzzi (1997), a relationship can be classified as either embedded or arm's-length (market-based). The embedded tie reflects the concept of social embeddedness introduced by Granovetter (1985), which refers to the personal nature of business relationships and their influence on economic processes. Embedded ties are characterized by trust, the exchange of refined or privileged information, and collaborative problem-solving. In contrast, the arm's-length tie represents the economic aspect of business relationships and features: lack of reciprocity between exchange partners, non-repetitive interactions, and a focus on economic efficiency. In this case, there is no social content in the relationship; transactions occur only once and are mainly driven by cost.

The strength of the tie and its level of embeddedness can be combined to create four types of ties: (1) strong and embedded; (2) strong and arm's-length; (3) weak and embedded; and (4) weak and arm's-length. These configurations can help explain the different practices of international academic cooperation.

According to Rossoni and Guarido Filho (2009), the growth of academic collaboration among researchers has enhanced understanding that scientific knowledge production is not just an individual effort but a process rooted in relationship networks. The rising number of studies carried out by researchers working in groups, networks, or other collaborative forms highlights the importance of viewing science as a social phenomenon (Lewis, 2010; Lewis et al., 2016; Moody, 2004; Sanderson, 2008). In this view, researchers mutually influence each other by sharing perspectives and conditions for their studies (Moody, 2004).

Rogers, Bozeman, and Chompalov (2001) argue that academic cooperation is best understood as a social activity that takes place within institutional contexts and relies on relationship networks. Several studies have connected relationship networks with academic cooperation as a foundation for developing social and human capital in research (Rogers; Bozeman; Chompalov, 2001; Bozeman; Corley, 2004; Jha; Welch, 2010; Newman, 2001; Rigby; Edler, 2005; Rothstein; Davey, 1995; Van Rijnsoever; Hessels, 2011).

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3 METHODOLOGICAL PROCEDURES

This study is characterized as qualitative, descriptive, and ex post facto research, with primary data gathered through semi-structured interviews. Secondary data included documents from the Graduate Programs (PPGs) under study, along with the Lattes résumés of the faculty members involved in these programs. The data collected were triangulated and analyzed using thematic content analysis.

Eight top-performing graduate programs, rated 6 and 7 in CAPES's 2013–2017 quadrennial evaluation, were selected for this study: five from the State University of Maringa (UEM) and three from the State University of Londrina (UEL), totaling 192 faculty members, with an average of 24 professors per program. The UEM programs included Agronomy (PGA), Ecology of Continental Aquatic Environments (PEA), Chemical Engineering (PEQ), Chemistry (PQU), and Animal Science (PPZ). At UEL, the programs were Science and Mathematics Education (PECEM), Experimental Pathology (PPE), and Animal Science (CCA). In total, 26 faculty members and 9 program coordinators agreed to participate in the interviews, making a total of 35 interviewees.

A total of 192 Lattes résumés from all faculty members in the selected PPGs were examined. Additionally, documents and reports related to internationalization—especially copies of reports submitted to CAPES for program evaluation—were also reviewed.

The rigorous application of research methodological procedures aimed to reduce biases and limitations. The study was conducted in accordance with the ethical standards established by the Permanent Committee on Ethics in Research with Human Beings (COPEP) at UEM, under Certificate of Ethical Clearance (CAAE) number 37703020.2.0000.0104.

4 DATA PRESENTATION AND ANALYSIS

This section presents and analyzes the data obtained in this study.

4.1 PRACTICES OF INTERNATIONAL ACADEMIC COOPERATION AMONG RESEARCHERS FROM HIGH-PERFORMING GRADUATE PROGRAMS AT STATE UNIVERSITIES IN PARANÁ AND INTERNATIONAL RESEARCHERS

The primary IAC practices performed by researchers from the selected PPGs are summarized in Table 2.

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Table 2 International Academic Cooperation Practices Conducted by Faculty Members of the Graduate Programs Studied

ACTIVITY	NUMBER OF FACULTY	AUTHORS
MOBILITY	28	
Sent or received students	16	Stallivieri (2004); Verdu (2019); Cavalheiro (2019); Knight and De Wit (1995); Larner (2015); Knight (2004); Sanches et al. (2016)
Sent or received professors/researchers	12	Stallivieri (2004); Verdu (2019); Cavalheiro (2019); Knight and De Wit (1995); Larner (2015); Knight (2004); Sanches et al. (2016)
PUBLICATIONS AND EDITORIAL ACTIVITIES	58	
Published articles in nationally indexed international journals	16	Crane (1972); Frame and Carpenter (1979); Meadows (1974); Newman (2001); Katz and Martin (1997); Sonnenwald (2007); Lewis et al. (2016); Stallivieri (2004)
Published in international journals alone or with national co-authors	16	Crane (1972); Frame and Carpenter (1979); Meadows (1974); Newman (2001); Katz and Martin (1997); Sonnenwald (2007); Lewis et al. (2016); Stallivieri (2004)
Published in international journals in co-authorship with foreign researchers	14	Crane (1972); Frame and Carpenter (1979); Meadows (1974); Newman (2001, 2004); Katz and Martin (1997); Sonnenwald (2007); Lewis et al. (2016); Stallivieri (2004)
Served as reviewer or editorial board member of international journals	12	Lewis et al. (2016)
SCIENTIFIC EVENTS	25	
Presented papers at international conferences	14	Sanches et al. (2016); Verdu (2019); Knight (2004); Solla Price (1976); Katz and Martin (1997)
Coordinated or organized international congresses, seminars, and/or events	6	Stallivieri (2004); Sanches et al. (2016); Solla Price (1976); Katz and Martin (1997)
Participated in international research visits, expeditions, or missions	5	Sanches et al. (2016)
SUPERVISION AND COMMITTEES	8	
Participated as a committee member abroad	6	Sanches et al. (2016)
Co-supervised or jointly supervised theses/dissertations abroad	2	Newman (2001, 2004)
RESEARCH NETWORKS AND PROJECTS	27	
Engaged in joint research projects with foreign researchers	10	Crane (1972); Sanches et al. (2016); Lewis et al. (2016); Knight (2004); Weiz and Roco (1996); Leite and Pinho (2016); Sundet (2017); Miura (2009)
Participated in international research groups/networks (formal or informal)	8	Crane (1972); Katz and Martin (1997); Lewis et al. (2016); Knight and De Wit (1995); Knight (2004); Georghiou (1998); Sonnenwald (2007); Bozeman (2010)
Established international academic cooperation	6	Stallivieri (2004); Sanches et al. (2016);

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ACTIVITY	NUMBER OF FACULTY	AUTHORS
agreements		Knight and De Wit (1995); Knight (2004); Crane (1972)
Participated in meetings or councils convened by international organizations	1	Stallivieri (2004); Sanches et al. (2016); Lewis et al. (2016)
Developed products or processes with shared patents or intellectual property with international researchers	2	Katz and Martin (1997); Stallivieri (2004)
RESEARCH FUNDING MANAGEMENT	9	
Conducted research funded by international agencies (grants, scholarships, stipends)	4	Knight and De Wit (1995); Knight (2004); Katz and Martin (1997); Stallivieri (2004); Sanches et al. (2016)
Participated in cost-sharing projects involving scientific instruments or infrastructure	4	Solla Price (1976); Katz and Martin (1997)
Responsible for managing research funds or laboratories abroad	1	Katz and Martin (1997)
CURRICULUM AND INTERNATIONALIZATION AT HOME	21	
Hosted international students or sent students abroad	8	Stallivieri (2004); Knight (2004); Bellen and Jones (2015); Nilsson (2003); Robson (2017)
Incorporated international dimensions in courses (content, readings, lectures or seminars in English or other languages, online classes with international partners)	7	Verdu (2019); Knight and De Wit (1995); Knight (2004); Bellen and Jones (2015); Nilsson (2003); Robson (2017); Lewis et al. (2016); Miura (2009)
Held international or intercultural events on the home campus	5	Knight and De Wit (1995); Knight (2004); Bellen and Jones (2015); Nilsson (2003); Robson (2017)
Participated in projects or groups related to degree validation or joint degrees with international institutions	1	Stallivieri (2004); Bellen and Jones (2015); Nilsson (2003); Robson (2017)
INTERNATIONAL AWARDS AND RECOGNITION	3	
Received international awards, honors, or recognition	3	–
OTHER / SPECIFY	7	
Developed journal clubs	2	–
Published chapters in international books	2	–
Served as a visiting professor at a foreign university	2	–
Worked as a consultant for multinational companies on international research projects	1	

Source: Elaborated by the authors.

Most professors believe that the most important international partnership or experience for themselves and their graduate programs (PPGs) is abroad academic training, as highlighted by Ramos (2018), Lewis (2010), Solla Price and Beaver (1966), and Beaver (2001), whether through master's, doctoral, postdoctoral studies, or other additional training programs. These formative experiences have led to many other international partnerships and collaborations. Opportunities to participate in international scientific events—where they can

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present and discuss research ideas with international scholars—and to join international research groups are also seen as crucial ways to build partnerships and support the internationalization of their PPGs.

The IAC practices examined in this study occur either formally or informally, as discussed by Georghiou (1998). They are mainly driven by individual faculty members' efforts to initiate and develop partnerships, often triggered by personal contacts (Solla Price; Beaver, 1966; Crane, 1972; Katz; Martin, 1997; Glänzel; Schubert, 2004; Bozeman; Fay; Slade, 2013; Beaver, 2001; Vanz; Stumpf, 2010; Eisend; Schmidt, 2014; Domingues, 2015; Lewis et al., 2012; Lukkonen et al., 1992; Sonnenwald, 2007; Louback, 2016; Middlehurst; Fielden, 2016; Barabási et al., 2002; Criswell; Zhu, 2015; Childress, 2010; Frame; Carpenter, 1979; Friesen, 2013; Hara et al., 2003; Knobel et al., 2013; Larner, 2015; Newman, 2001; Nhoria; Eccles, 1994; Proctor, 2015; Silva; Rocha Neto; Schetinger, 2018; Sundet, 2015, 2017; Sutton, 2010). When research development requires financial, structural, material, or technological resources, collaboration usually becomes formalized. Conversely, if such resources are not needed, partnerships tend to stay informal (Lewis, 2010; Lewis et al., 2016; Leydesdorff et al., 2014; Newman, 2004; Sutton, 2015; Clegg et al., 2016; Willis; Strivens, 2015; Barbosa Neto; Cunha, 2016; Leite; Pinho, 2016; Wutchy et al., 2007; Zhao et al., 2014; Stallivieri, 2002; Oliveira et al., 2017; Sanches et al., 2016; Leal et al., 2018).

4.2 THE RELATIONSHIP NETWORK BETWEEN RESEARCHERS FROM HIGH-PERFORMING GRADUATE PROGRAMS AT STATE UNIVERSITIES IN PARANÁ AND INTERNATIONAL RESEARCHERS

The network of relationships among researchers from the PPGs being studied and international researchers can be categorized into four types: (1) almost like family; (2) close friends; (3) co-workers; and (4) on-demand colleagues. The relationships among these researchers did not show signs of weak or arm's-length connections.

Table 3 Relationships between Researchers from the Graduate Programs Studied and International Researchers

	Highly Embedded Ties	Embedded Ties
Very Strong Ties	Almost like family	Close-Friends
Strong Ties	Co-Workers	On-Demand Colleagues

Source: The authors, based on research data and on Granovetter (1973, 1985) and Uzzi (1997).

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The relationships characterized by very strong and highly embedded ties are called **"almost like family"**. In this type of relationship, interactions are frequent and emotionally intense, marked by reciprocity, shared values, and exchanges across a wide range of personal and professional issues (Granovetter, 1973, 1985). These ties also display high levels of trust, refined information sharing, and collaborative problem-solving, which are typical of embedded relationships (Uzzi, 1997). All elements are present, described as frequent and intense.

These relationships are characterized by deep closeness and strong affection, often expressed through phrases such as "we are very close," "we're like siblings," or "it's almost like a marriage." Sometimes, family members from both sides are involved, and this involvement affects how international collaborations develop and turn out. The main goal of these partnerships is to maintain ongoing academic and research collaboration with the identified partner.

Such ties often develop between Brazilian researchers and their doctoral or postdoctoral advisors, or with faculty members and colleagues from research groups they collaborated with during or after their academic training or international mobility. The so-called "almost like family" relationships include deeply personal aspects, such as strong friendships and family-like bonds, like godparent roles, hosting each other's children, attending family events like weddings, birthdays, and funerals, supporting each other through family health crises, exchanging gifts, and traveling together for both professional and personal reasons.

Reports of longing and vivid emotional memories were common, often accompanied by tears and pauses when researchers discussed their international partners. The sentiments shared by PPG faculty about their research collaborators abroad showed strong feelings of fraternal love and gratitude, especially among those with deep and close ties.

The relationships characterized by very strong and embedded ties are called **"close-friends"**. These relationships are built on frequent contact, emotional bonds, reciprocity, shared values, and diverse topics (Granovetter, 1973, 1985). They show trust, detailed information sharing, and joint problem-solving—signs of embedded ties (Uzzi, 1997). However, in this case, the main focus of the partnership is on its economic results—that is, on research findings, publications, and the potential for future collaborations—rather than on the

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relationship itself. These partnerships did not always last after a project ended and were seen as less intense and less embedded than the "almost like family" relationships.

What fundamentally distinguishes "close-friends" from "almost like family" is the emphasis on professional output. While the relationship may be described as a close friendship, the friendship itself is not the main focus. In "almost like family" partnerships, the emotional bond and the relationship are considered more important than the academic results. Conversely, for "close-friends," both the relationship and research achievements are equally valued. This balance probably marks the most important difference between these two types of relationships.

The relationships defined by strong and highly embedded ties were referred to as **"co-workers."** These relationships are based on frequent interactions during research activities, without emotional bonds or what participants described as "professional friendship." They involve reciprocity in dividing tasks and responsibilities, but shared values and broader topics are not consistently present; when they are, it is occasional, which aligns with the characteristics of strong ties (Granovetter, 1973, 1985). These ties include trust, refined information exchange, and collaborative problem-solving, making them embedded (Uzzi, 1997). The main focus of these relationships is developing collaborative research and boosting scientific productivity, especially through joint publications and conference presentations. While emotional intensity is lower, professional commitment remains very high.

The relationships marked by strong and embedded ties were referred to as **"on-demand colleagues."** These ties concentrate on the development of research work and outcomes, with frequent contact occurring only during the research process. Emotional bonds are minimal, but reciprocity is good. Sharing of personal values is rare, and discussions outside of research are limited to general preferences or topics like politics, science, or current events (Granovetter, 1973, 1985). These relationships display trust, some level of refined information exchange, and often include joint problem-solving, qualifying them as embedded (Uzzi, 1997). However, the main focus remains economic—centered on research results and publications. Emotional ties are superficial, and sharing of personal values and non-academic topics happens infrequently, mostly revolving around scientific work. These relationships typically end after the project is completed and results are shared. While not classified as

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weak or arm's-length ties, they are the least strong and least embedded of all relationship types.

5 CONCLUSIONS AND RECOMMENDATIONS

This study aimed to explore the practices of international academic cooperation (IAC) between researchers from top graduate programs (PPGs) at Paraná state universities and international researchers, while also analyzing the structure of their relationship networks.

It can be affirmed that the relationship networks of researchers from the PPGs studied act as enablers of IAC. The IAC that develops from these networks fosters the internationalization of the PPGs to which these researchers belong and creates opportunities for colleagues, students, and the institution itself to participate in new international experiences, aiding the growth of global knowledge and science. Relationship-based IAC accounts for a significant part of the internationalization of PPGs, especially concerning research activities.

It is important to emphasize that international academic training was considered the most significant international experience by the researchers interviewed. This educational experience helped develop connections with foreign researchers and directly contributed to the emergence of IAC throughout their academic careers. The relationships formed during graduate training were also crucial for bringing international researchers to Brazil, helping them better understand local research practices and fostering new collaborations. Participation in international scientific events and research groups was also seen as a key way to generate IAC, as long as meaningful relationships are built and maintained.

The network of relationships among researchers from the PPGs studied and their international counterparts was characterized by very strong and highly embedded ties like "almost like family" and "close-friends," as well as strong and embedded ties such as "co-workers" and "on-demand colleagues." No weak or arm's-length ties were observed.

IAC was found to be linked to the need for resources and legal procedures. Informal academic collaborations usually don't require financial, structural, or institutional resources, nor formal agreements or contracts. In contrast, formal cooperation generally depends on such resources for research development. These resources can include financial support, infrastructure, materials, or technology.

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The relationship between types of ties (strong, weak, embedded, and arm's-length) and the types of IAC practices (formal and informal) among faculty members and their international collaborators shows certain patterns. The stronger and more embedded the tie, the more likely it is to involve informal IAC. Co-workers and on-demand colleagues tend to participate in formal cooperation. Conversely, almost like family and close-friends are more inclined to engage in informal partnerships. Exceptions to this pattern happen when almost like family or close-friend partnerships require funding or documentation for academic mobility, which makes formalization necessary.

Language was identified as a barrier and challenge to IAC, affecting both faculty and students. It creates difficulties for participation and integration within the international scientific community. Therefore, foreign language training, especially in English, is a vital need for PPGs.

Future research should replicate this study across various contexts and samples, including: (1) other public state or federal universities; (2) private higher education institutions; (3) PPGs categorized by field of knowledge; (4) PPGs rated 4 or 5 in CAPES evaluations; (5) foreign researchers seeking collaborations with Brazilian researchers; and (6) PPGs from international institutions.

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