

Article

Panorama of Undergraduate Research in Brazil: Profile, Scientific Production, and Perceptions

Angélica Ferreira Melo^{1,2}, Woska Pires da Costa^{1,3,*} , Rhanya Rafaella Rodrigues¹ ,
Lorena de Almeida Cavalcante Brandão Nunes¹ , Priscilla Rayanne E Silva Noll^{1,4}  and Matias Noll^{1,5,6,*} 

¹ Instituto Federal Goiano—Campus Ceres, GO-154 Highway, Km 03, Rural Area, P.O. Box 51, Ceres 76300-000, GO, Brazil

² Instituto Federal Goiano—Campus Rio Verde, Sul Goiana Highway, Km 01, Rural Area, P.O. Box 66, Rio Verde 75901-970, GO, Brazil

³ Instituto Federal Goiano—Campus Morrinhos, BR-153 Highway, Km 633, Rural Area, P.O. Box 92, Morrinhos 75620-000, GO, Brazil

⁴ Faculdade de Medicina, Universidade de São Paulo, Dr. Arnaldo Avenue, 455, Cerqueira César 01246-903, SP, Brazil

⁵ Faculdade de Educação Física e Dança, Universidade Federal de Goiás, Samambaia Campus, Goiânia-Nerópolis Highway, Km-12, P.O. Box 131, Goiânia 74001-970, GO, Brazil

⁶ Faculdade de Nutrição, Universidade Federal de Goiás, 227 Street, Block 68, Goiânia 74605-080, GO, Brazil

* Correspondence: woskpac@gmail.com (W.P.d.C.); matias.noll@ifgoiano.edu.br (M.N.)

Abstract: Undergraduate Research (UR) is an institutional program that introduces undergraduate students to scientific research. The program selects research projects proposed by advisors and students for execution. Despite the importance of knowing the stages of research activities in undergraduate research, only a few studies have evaluated data on this subject. Therefore, this study aims to outline an overview of UR in a Brazilian educational institution, considering the profiles of students and advisors, students' scientific productions, and perceptions about the experience of both. The study was a mixed-approach case study conducted through a questionnaire and interviews. The sample consisted of 213 undergraduate students and 167 UR supervisors. The results show that the largest group of students were aged 21 and 22 (46.6%) and supervisors 33 to 38 years (38.9%). Regarding the scientific productions of students, those who participated twice or more in undergraduate research had higher indicators compared to those who were participating for the first time. Students' perceptions of their evolution and perceptions of the advisors were mostly positive, with a greater number of responses classified as very good to good. Thus, the satisfaction of researchers in being part of this experience was perceived and the need to improve the scientific production indicators of students, mediated by the advisors stimulating the writing of articles, abstracts, and books, as well as participation in events and patent development, was shown. We conclude that undergraduate research activities promote the integral development of students' academic, scientific, personal, and professional terms, which ultimately reflect critical and emancipatory actions in society.

Keywords: science education; undergraduate research experience; research; bibliographic production



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1. Introduction

In Brazil, Undergraduate Research (UR) is an institutional research program whose main purpose is to involve students during the school period in scientific and technological research; thus, it aims to train qualified human resources [1]. Scientific research consists of rigorous activities conducted through the interaction between methods, theories, and discoveries. This type of research requires the possibility of testing, thus allowing scientific knowledge to be built, reconstructed, and contested by other studies [2].

Encouraging young people to understand and act on scientific research is essential for a nation to progress towards reducing scientific and technological dependence on other

countries. For this, students' identification with science can be strongly related to their participation in scientific research programs [3]. These programs can increase students' intentions to pursue a scientific career [4–7] or direct them to other professional activities, that is, to the world of work [8]. Moreover, research programs can improve students' scientific reasoning, encouraging them to think as scientists [9].

Scientific education provides students with theoretical, technical, practical, and methodological knowledge. Once combined, this knowledge favors the development of skills for dealing with problematic situations and challenges, which is not only limited to the formative experience but also reverberates in skillful actions in the future. Furthermore, it trains critical and active subjects qualified for the exercise of citizenship, which is expected to promote social and cultural transformation [10].

Undergraduate scientific research experience should be stimulated [11] since it brings benefits to students [12–16], including participation in conferences [17], improved understanding of project management, research techniques and the dynamics of graduate studies [11], development of communication skills [16,18], development of team ethics, and problem-solving [16]. Additionally, it contributes to modifying epistemological misconceptions about science and promoting data analysis and interpretation skills [19]. Moreover, in view of the continuous process of an investigation, the results obtained by the researchers must be recorded. These records are the basis of scientific productions that are important for scientific processes [20].

In the case of research students, a profile is sought that demonstrates their involvement with the undergraduate course, their academic performance, and interest in the area [21]. Supervisors must have solid experience in research, with proven scientific production and the ability to train qualified human resources [21]. The expectation is that, through this guidance process, it will be possible to provide students with a more comprehensive and enriching training, in addition to contributing to the advancement of knowledge in their areas of interest.

Although UR brings benefits to students, it is important to consider the barriers that exist between them and UR, which limit participation and result in low engagement rates. However, when students overcome these barriers, their perceptions of science, future careers, and the world expand with intelligence and maturity [22]. To improve student engagement in UR programs, it is essential that higher education institutions provide adequate resources, quality guidance, and recognition for work done. This way, institutions would create the conditions necessary to expand the number of undergraduate students engaged in scientific research, contributing to the advancement of knowledge in different areas of study.

The UR programs offered by Brazilian educational institutions are linked to the National Council for Scientific and Technological Development (*Conselho Nacional de Desenvolvimento Científico e Tecnológico—CNPq*). The body is mandated to promote scientific research and the training of human resources. Institutional programs select research projects to be carried out by a student and supervised by a qualified advisor through a public call for applications [23]. In higher education, we highlight two institutional programs for research grants and their voluntary versions: the Institutional Program for Undergraduate Research Scholarships (*Programa Institucional de Bolsas de Iniciação Científica—PIBIC*), whose purpose is the development of scientific thinking and initiation of research; and the Institutional Program for Initiation Scholarships in Technological Development and Innovation (*Programa Institucional de Bolsas de Iniciação em Desenvolvimento Tecnológico e Inovação—PIBITI*), which aims to stimulate the development and transfer of new technologies and innovation [1].

Created in 1989, *PIBIC* is one of the oldest Brazilian scientific programs [24]; however, only a few studies have been conducted on the experiences [25] and motivations of students conducting scientific research during UR [26]. Some articles discuss partial themes related to scientific communication [27] and initial teacher training for the UR [24], among others. Upon analyzing existing studies conducted in the Brazilian context, we noticed that none of them evaluated both students and supervisors in the same study, utilized a representative

sample, or used a mixed-methods approach to investigate UR context. In this perspective, studies that evaluate both students and advisors are needed to obtain a broader view of research programs and their participants. Thus, it is possible to know how the critical and active actions, as well as the different sets of knowledge, such as the formative experience and skillful actions by UR, are formed. Therefore, to draw a panorama of UR in a Brazilian educational institution, the present study aimed to analyze the profile of students and their advisors, and their perceptions about the UR experience. Moreover, this study also aimed to evaluate the students' scientific production.

The relevance of our study is to obtain a broader view of research programs and their participants. In this regard, we chose to use a mixed-methods case study approach, which will assess the scientific production indicators of the students and their advisors, in addition to giving voice to the participants in this experience.

2. Method

This research is characterized by a mixed-approach case study [28], which is part of an umbrella study named "Panorama of Undergraduate Research in Brazil" (PUR-Bra study). A case study can be defined as the study of certain individuals, professions, conditions, institutions, groups, or communities to obtain generalizations based on the cases [28,29]. The particular case of this study refers to the Federal Institute of Education, Science and Technology Goiano (*Instituto Federal de Educação, Ciência e Tecnologia Goiano—IF Goiano*).

The mixed approach can be defined as research that associates quantitative and qualitative evidence to corroborate results [28]. Both approaches have their potential and limitations, and it is advisable to integrate them to explore a field in such a way that other approaches would not allow [29].

2.1. Context

The study was carried out at the *IF Goiano*, a Brazilian public educational institution located in Goiás State. Figure 1 highlights that IF Goiano is located in the central region of the country, both in the central region and the interior of the state. The institution has twelve campuses in different cities, in which, courses are offered from high school to doctorate programs. *IF Goiano* is part of the Federal Network of Professional, Scientific and Technological Education linked to the Ministry of Education and is present in all Brazilian states, including the Federal District.

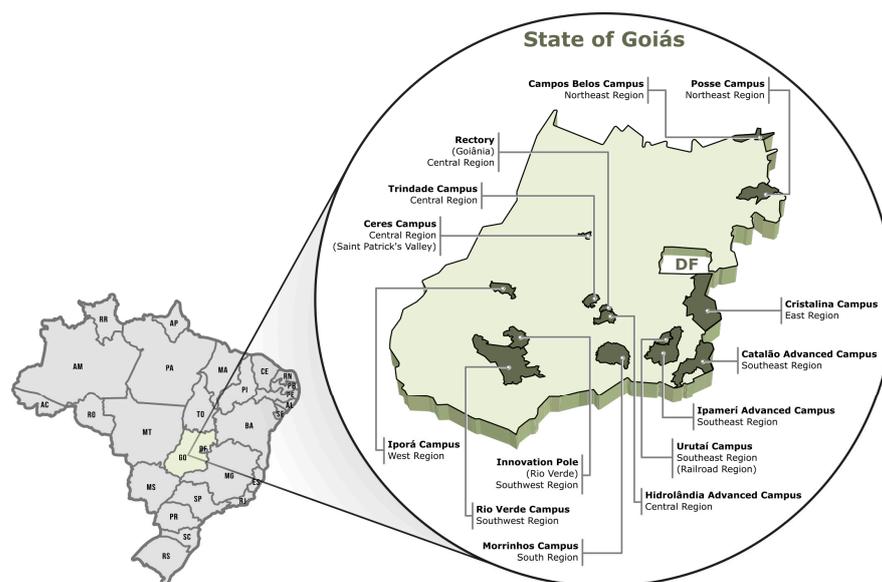


Figure 1. Map of Brazil with the location of the *IF Goiano* campuses, in the central region of the country, based on information from the units and the institutional website (<https://ifgoiano.edu.br/>, accessed on 5 March 2023).

This contextualization is important, especially with regard to the location of the campuses, which are located in the interior of the state. The *IF Goiano* was established in 2008, from the extinct Federal Agrotechnical Schools. Afterwards, new units were created and the offer of courses was diversified, however, for the most part, the agricultural vocation remains consolidated.

In order to fulfill its institutional mission, the following undergraduate courses were offered by *IF Goiano* in 2019, covering a total of 7,890 enrolled students: 13 technology graduation, 18 degrees, and 32 bachelors' [30]. In relation to strict sense postgraduate courses, the following were offered (657 enrolled students): 11 master's degrees and one doctorate [30]. In addition to these, some broad sense specializations (780 enrolled students) and several mid-level technical courses were offered (8677 enrolled students).

2.2. Population and Sample

The target population of this study consisted of undergraduate students, professors, and technicians who guided UR projects linked to the *IF Goiano* evaluated from 2018 to 2019. The study population consisted of 592 students and 307 advisors, who were invited to participate in the research through an e-mail sent by the researchers.

The sample was selected for convenience, where the subjects who agreed to participate voluntarily signed an Informed Consent Form (ICF) whose ethical precepts were followed according to the Brazilian legislation. The research design was submitted and approved by the *IF Goiano* Research Ethics Committee (*Comitê de Ética em Pesquisa—CEP*—protocol no. 08499119.9.0000.0036). The sample consisted of 213 students and 167 advisors in the quantitative phase and six students and six advisors in the qualitative phase.

We took as a base the official model adopted by the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística—IBGE*) to classify the participants of this research in relation to their ethnic origins (which classifies the Brazilian population based on skin color): white (*branco*), black (*preto*), East Asian (*amarelo*), indigenous (*indígena*), or mixed (*pardo*), as a routine [31,32]. The term *pardo* is used in Brazil to refer to people of mixed ethnic ancestries, but it is complex [31] and pejorative in some contexts. To clarify this issue, we have chosen to use well recognized terms in the literature: Afro-descendants referring to black skin, Caucasian-descendants referring to white skin, East Asian descendants referring as yellow skin, indigenous referring to Brazilians' indigenous, and mixed ethnicity (i.e., African ancestry mixed with other ethnicities) referring to the official *IBGE* term called *pardo*.

2.3. Data Collection Procedures

We used three data collection procedures: questionnaire (see Appendices A and B), interviews (see Appendices C and D), and document analysis.

The questionnaire was administered through the electronic tool Google Forms and sent by e-mail to all students and advisors from 2018 to 2019. The subjects covered in both questionnaires, which were available for responses from October to December 2019, referred to the contributions of the research experience to the student, on the relationship with the advisor, on institutional support, and on the level of satisfaction in relation to the program that was linked. Subsequently, the data were tabulated in a Microsoft Excel™ spreadsheet and inserted into statistical software for analysis.

The second stage of data collection, which occurred between October and November of 2019, was semi-structured individual interviews with some of the students and advisors, guided by a question script. The selection of respondents was randomly stratified so that the sample represented the population. The interviews were audio-recorded and anonymized using a code; the participant's identification was by means of letters: "S" for student and "A" for advisor.

The third procedure was documentary analysis by evaluating the Lattes Curriculum (history of scientific and academic Brazilian researchers) of the students who answered the questionnaire. We established two groups of students for comparison: those who

participated in the research program for the first time and those who were participating for the second time or more. Information on the production of scientific articles, scientific articles published in English, simple abstracts, expanded abstracts, books/chapters, and patent registration were extracted, considering their entire academic production, without time restrictions.

2.4. Validation of Research Instruments

After defining the research instruments, we checked their validity by administering a pre-test to a part of the population. Administering a pre-test on a small population with similar characteristics before administering the final version of the questionnaire is highly recommended [33,34].

Students and advisors voluntarily participated in the content validation of the questionnaire and interviews. Thirty-eight evaluators participated in the content analysis, answered the research questions, and made their evaluations. The included items were [27]: (a) organization, (b) objectivity, (c) clarity, (d) ease of reading, and (e) understanding of the content. The questions were analyzed according to the Content Validity Index (CVI), which measures the proportion of evaluators who agreed on a certain aspect of the instrument and its items [34].

Each evaluator analyzed the relevance level of each question by choosing one of the following options from a 5-point Likert scale [35,36]: “very good” (5 points), “good” (4 points), “fair” (3 points), “weak” (2 points), and “very weak” (1 point). The index score was calculated for each question assessed, considering the total number of evaluators that agreed on the items choosing options “5” or “4” divided by the total number of responses [27,34,37]. All questions had a CVI value of $\geq 75\%$, which allowed us to keep the questions as they were initially elaborated [33]. After applying the instruments, we proceeded to the analysis data.

2.5. Statistical Analysis

The data were analyzed using descriptive and inferential statistics, by the software Statistical Package for the Social Sciences (IBM™ SPSS™ Statistics), version 26 for Microsoft Windows™. Absolute numbers and percentages were used for the descriptive analysis of the data. The chi-square (p) value was calculated [38,39]. To avoid statistical power loss, the last three answer options for each question were grouped and classified as “very good”, “good”, and “fair/weak/very weak” options (see Appendix A: questions 9–25, and Appendix B: questions 9–25). For example, the responses for the last three options (i.e., “indifferent”, “partially disagree”, and “totally disagree”) related to question 10 were grouped and, in the analysis, this group of answers was compared with the recorded for the options “totally agree” and “partially agree” of the same question. If we did not proceed in this way, the frequencies of each of the three response options would be lower, which would compromise data analysis.

The mean and standard deviation were used in the students’ scientific production, and the normality of the data was assessed using the Kolmogorov–Smirnov test [40,41]. Given the non-normal distribution observed, we used a non-parametric test, the Mann–Whitney U -test, to assess whether there was a statistically significant difference ($p < 0.05$) [40,42].

2.6. Content Analysis

Content Analysis (CA) is defined as a set of communication analysis techniques that uses systematic procedures and objectives to describe the content of messages [43]. Therefore, the CA technique was used to interpret the qualitative data obtained by interviews. Following the guidelines, the interviews were audio-recorded for later literal transcription, reading, categorization, and analysis of students’ and supervisors’ discourses [44].

Thus, thematic axes were identified based on the interviewees’ discourses, and categories and subcategories were subsequently created to achieve the study’s objective [43];

that is, the categories and subcategories were defined according to the perceptions of students and advisors about the research programs.

3. Results

For a better analysis, the results of this study were analyzed separately in the next two subsections, in terms of quantitative and qualitative data.

3.1. Quantitative Measures

Most of the students who answered the questionnaire were female ($n = 115$; 54.0%), and most of the advisors were male ($n = 96$; 57.5%), as shown in Tables 1 and 2, respectively. The most prevalent knowledge field among students was Agrarian Sciences ($n = 132$; 62.0%). This was also true for advisors ($n = 87$; 52.1%). Data related to color/ethnicity show a higher number of mixed students (59.2%, Table 1) in the research programs in this period. On the other hand, most supervisors who work at the *IF Goiano* are white (57.5%, Table 2), and this indicates that, despite the insertion opportunities, there are still barriers for the less favored categories to establish themselves in the academy as supervisors, such as mixed (31.1%, Table 2).

Table 1. Profile of students of the research programs in force from 2018 to 2019.

Variables	Frequency	
	(n)	%
Students	213	100.0
Sex		
Female	115	54.0
Male	98	46.0
Age range		
19 to 20 years	48	22.5
21 to 22 years	99	46.6
23 to 24 years	41	19.2
25 years or more	25	11.7
Color/ethnicity		
Mixed	126	59.2
White	61	28.6
Black	17	8.0
Yellow	6	2.8
I do not wish to answer	3	1.4
Indigenous	0	0.0
Field of knowledge		
Agrarian Sciences	132	62.0
Exact and Earth Sciences	30	14.1
Biological Sciences	26	12.2
Engineering	16	7.5
Humanities	3	1.4
Applied Social Sciences	5	2.3
Health Sciences	1	0.5
Linguistics, Languages, and Arts	0	0.0
Student		
Receiving a scholarship	132	62
Voluntary	81	38

Note: The 'n' column represent the absolute frequency, while the '%' column represent the relative frequency.

We analyzed the impact of research on the scientific production of students who participated in a UR cycle and those who had already participated in two or more cycles (Table 3). We found that participation in research programs for more than one term is associated ($p < 0.001$) with a higher average production of scientific articles, scientific articles in English, expanded abstracts, and simple abstracts.

Table 2. Profile supervisors of the research programs in force from 2018 to 2019.

Variables	Frequency	
	(n)	%
Advisors	167	100.0
Sex		
Male	96	57.5
Female	71	42.5
Profile of the advisor		
Professor at <i>IF Goiano</i>	152	91.0
Administrative technician at <i>IF Goiano</i>	10	6.0
Visiting professor or researcher officially linked to <i>IF Goiano</i> 's research activities	4	2.4
Professor/researcher external to the <i>IF Goiano</i> campus	1	0.6
Age range		
27 to 32 years	32	19.2
33 to 38 years	65	38.9
39 to 44 years	41	24.5
45 to 50 years	13	7.8
51 years or more	16	9.6
Color/ethnicity		
White	96	57.5
Mixed	52	31.1
Black	11	6.6
Yellow	5	3.0
Indigenous	2	1.2
I do not wish to answer	1	0.6
Field of knowledge		
Agrarian Sciences	87	52.1
Exact and Earth Sciences	32	19.1
Humanities	13	7.8
Biological Sciences	12	7.2
Engineering	11	6.6
Linguistics, Languages, and Arts	6	3.6
Applied Social Sciences	4	2.4
Health Sciences	2	1.2
Highest academic degree		
Doctorate	136	81.4
Master's degree	31	18.6

Note: The 'n' column represent the absolute frequency, while the '%' column represent the relative frequency.

Table 3. Scientific production considering whether the students participated one or more times in the research programs.

Variables	Participation		p-Value
	1st Time <i>M</i> ± <i>SD</i>	2nd Time or More <i>M</i> ± <i>SD</i>	
Scientific articles	0.07 ± 0.35	1.18 ± 3.02	<0.001
Scientific articles in English	0.03 ± 0.16	0.52 ± 1.53	<0.001
Expanded abstracts	0.90 ± 2.28	4.70 ± 5.54	<0.001
Simple abstracts	0.99 ± 2.09	4.75 ± 5.86	<0.001
Books and chapters	0.08 ± 0.34	0.11 ± 0.42	0.690
Patents	0.03 ± 0.29	0.13 ± 1.03	0.525
All productions	2.10 ± 4.02	11.38 ± 12.89	

Note: *M* and *SD* represent mean and standard deviation, respectively. Mann–Whitney *U*-test ($\alpha = 0.05$).

The students' perceptions were compared with the advisors' perceptions of students, advisors, institutions, and programs (Table 4). The items with the highest agreement between the two were those about the importance of research during undergraduate studies (89.2%), knowledge aggregation (88.9%), and the learning of research methods and techniques (84.5%). The item with the lowest agreement was regarding interaction with foreign languages during to research activities (i.e., reading, interpretation, and writing in foreign languages), with most of the respondents partially agreeing with it (37.9%).

Table 4. Perception of students and advisors on the experience of participating in UR programs.

Variables	Total (N = 380) n (%)	Students (N = 213) n (%)	Advisors (N = 167) n (%)	p-Value
(a) Student evolution during UR				
Very good	190 (50.0)	123 (57.7)	67 (40.1)	<0.001
Good	146 (38.4)	76 (35.7)	70 (41.9)	
Fair	39 (10.3)	13 (6.1)	26 (15.6)	
Poor	5 (1.3)	1 (0.5)	4 (2.4)	
Very poor	0 (0.0)	0 (0.0)	0 (0.0)	
(b) Importance of UR during undergraduate studies				
Totally agree	339 (89.2)	187 (87.7)	152 (91)	0.599
Partially agree	38 (10.0)	24 (11.3)	14 (8.4)	
indifferent	1 (0.3)	1 (0.5)	0 (0.0)	
Partially disagree	2 (0.5)	1 (0.5)	1 (0.6)	
Strongly disagree	0 (0.0)	0 (0.0)	0 (0.0)	
(c) Interest in scientific research				
Totally agree	272 (71.6)	149 (70)	123 (73.7)	0.088
Partially agree	98 (25.8)	55 (25.8)	43 (25.7)	
indifferent	4 (1.0)	4 (1.9)	0 (0.0)	
Partially disagree	6 (1.6)	5 (2.3)	1 (0.6)	
Strongly disagree	0 (0.0)	0 (0.0)	0 (0.0)	
(d) Adds knowledge				
Totally agree	338 (88.9)	184 (86.4)	154 (92.2)	0.084
Partially agree	38 (10.0)	25 (11.7)	13 (7.8)	
indifferent	3 (0.8)	3 (1.4)	0 (0.0)	
Partially disagree	1 (0.3)	1 (0.5)	0 (0.0)	
Strongly disagree	0 (0.0)	0 (0.0)	0 (0.0)	
(e) Develops critical thinking				
Totally agree	303 (79.7)	164 (77.0)	139 (83.2)	0.087
Partially agree	68 (17.9)	41 (19.2)	27 (16.2)	
Indifferent	6 (1.6)	5 (2.4)	1 (0.6)	
Partially disagree	2 (0.5)	2 (0.9)	0 (0.0)	
Strongly disagree	1 (0.3)	1 (0.5)	0 (0.0)	
(f) Stimulates creativity				
Totally agree	267 (70.3)	140 (65.7)	127 (76.0)	0.002
Partially agree	99 (26.0)	59 (27.7)	40 (24.0)	
Indifferent	11 (2.9)	11 (5.2)	0 (0.0)	
Partially disagree	2 (0.5)	2 (0.9)	0 (0.0)	
Strongly disagree	1 (0.3)	1 (0.5)	0 (0.0)	
(g) Develops responsibility				
Totally agree	278 (73.2)	150 (70.4)	128 (76.6)	0.013
Partially agree	80 (21.0)	44 (20.6)	36 (21.6)	
Indifferent	19 (5.0)	17 (8.0)	2 (1.2)	
Partially disagree	2 (0.5)	1 (0.5)	1 (0.6)	
Strongly disagree	1 (0.3)	1 (0.5)	0 (0.0)	
(h) Performance of the planned activities on time				
Totally agree	224 (59.0)	127 (59.6)	97 (58.1)	0.002
Partially agree	132 (34.7)	65 (30.5)	67 (40.1)	
Indifferent	21 (5.5)	18 (8.5)	3 (1.8)	
Partially disagree	3 (0.8)	3 (1.4)	0 (0.0)	
Strongly disagree	0 (0.0)	0 (0.0)	0 (0.0)	
(i) Knowledge acquisition, learning about research methods and techniques				
Totally agree	321 (84.5)	179 (84.0)	142 (85.0)	0.742
Partially agree	55 (14.5)	31 (14.6)	24 (14.4)	
Indifferent	4 (1.0)	3 (1.4)	1 (0.6)	
Partially disagree	0 (0.0)	0 (0.0)	0 (0.0)	
Strongly disagree	0 (0.0)	0 (0.0)	0 (0.0)	
(j) Arouses interest in scientific writing				
Totally agree	210 (55.3)	118 (55.4)	92 (55.1)	0.002
Partially agree	139 (36.6)	69 (32.4)	70 (41.9)	
Indifferent	23 (6.1)	19 (8.9)	4 (2.4)	
Partially disagree	4 (1.0)	4 (1.9)	0 (0.0)	
Strongly disagree	4 (1.0)	3 (1.4)	1 (0.6)	

Table 4. Cont.

Variables	Total (N = 380) n (%)	Students (N = 213) n (%)	Advisors (N = 167) n (%)	p-Value
(k) Encouraged presentation of papers orally				
Totally agree	252 (66.3)	130 (61.0)	122 (73.1)	<0.001
Partially agree	95 (25.0)	54 (25.4)	41 (24.5)	
Indifferent	26 (6.8)	23 (10.8)	3 (1.8)	
Partially disagree	3 (0.8)	2 (0.9)	1 (0.6)	
Strongly disagree	4 (1.1)	4 (1.9)	0 (0.0)	
(l) Relationship between advisors and students				
Very good	263 (69.2)	161 (75.6)	102 (61.1)	<0.001
Good	98 (25.8)	37 (17.3)	61 (36.5)	
Fair	17 (4.4)	14 (6.6)	3 (1.8)	
Poor	1 (0.3)	1 (0.5)	0 (0.0)	
Very poor	1 (0.3)	0 (0.0)	1 (0.6)	
(m) Better performance graduate studies				
Totally agree	281 (74.0)	145 (68.1)	136 (81.4)	0.012
Partially agree	91 (23.9)	62 (29.1)	29 (17.4)	
Indifferent	6 (1.6)	4 (1.9)	2 (1.2)	
Partially disagree	2 (0.5)	2 (0.9)	0 (0.0)	
Strongly disagree	0 (0.0)	0 (0.0)	0 (0.0)	
(n) Acquisition of a more prestigious job				
Totally agree	207 (54.5)	126 (59.2)	81 (48.5)	0.053
Partially agree	136 (35.8)	65 (30.5)	71 (42.5)	
Indifferent	21 (5.5)	14 (6.6)	7 (4.2)	
Partially disagree	8 (2.1)	5 (2.3)	3 (1.8)	
Strongly disagree	8 (2.1)	3 (1.4)	5 (3.0)	
(o) Encouragement to have contact with foreign languages				
Totally agree	131 (34.5)	68 (31.9)	63 (37.7)	<0.001
Partially agree	144 (37.9)	69 (32.4)	75 (44.9)	
Indifferent	64 (16.8)	40 (18.8)	24 (14.4)	
Partially disagree	17 (4.5)	13 (6.1)	4 (2.4)	
Strongly disagree	24 (6.3)	23 (10.8)	1 (0.6)	
(p) Institutional support for scientific research activities				
Totally agree	240 (63.2)	146 (68.5)	94 (56.3)	0.036
Partially agree	120 (31.6)	59 (27.7)	61 (36.5)	
Indifferent	4 (1.0)	2 (0.9)	2 (1.2)	
Partially disagree	12 (3.2)	4 (1.8)	8 (4.8)	
Strongly disagree	4 (1.0)	2 (0.9)	2 (1.2)	
(q) Satisfaction level				
Very satisfied	135 (35.5)	106 (49.8)	29 (17.4)	<0.001
Satisfied	199 (52.4)	86 (40.4)	113 (67.7)	
Reasonably satisfied	38 (10.0)	15 (7.0)	23 (13.7)	
Dissatisfied	6 (1.6)	5 (2.3)	1 (0.6)	
Very unsatisfied	2 (0.5)	1 (0.5)	1 (0.6)	

Note: The 'n' columns represent the absolute frequency, while the '%' columns represent the relative frequency. Mann–Whitney *U*-test ($\alpha = 0.05$): each letter is used to represent a variable. To avoid statistical power loss, the last three answer options for each question were grouped and classified as "very good", "good", and "fair/weak/very weak" options (see Appendix A: questions 9–25, and Appendix B: questions 9–25).

The results indicated ($p < 0.001$) different perceptions of students and advisors on (a) student evolution, the (k) stimulus to present papers orally, the (l) relationship between student and advisor, (o) contact with foreign languages, and (q) level of satisfaction. Differ-

ences were observed ($p = 0.002$) for stimulation of (f) creativity, (h) personal organization to carry out the activities on time, and (j) interest in scientific writing. The results also suggest distinctions between these two groups for the following variables: (m) best performance in graduate studies ($p = 0.012$), (g) student responsibility ($p = 0.013$), and (p) institutional support for research activities ($p = 0.036$).

3.2. Qualitative Measures

After analyzing the interviews, the results were grouped into thematic axes by categories. The axes for students include the “Importance of research programs” (Figure 2), “Project execution” (Figure 3), “Difference from other students” (i.e., who did not have UR experience) (Figure 4), and the “Association between research programs and professional activities” (Figure 5).

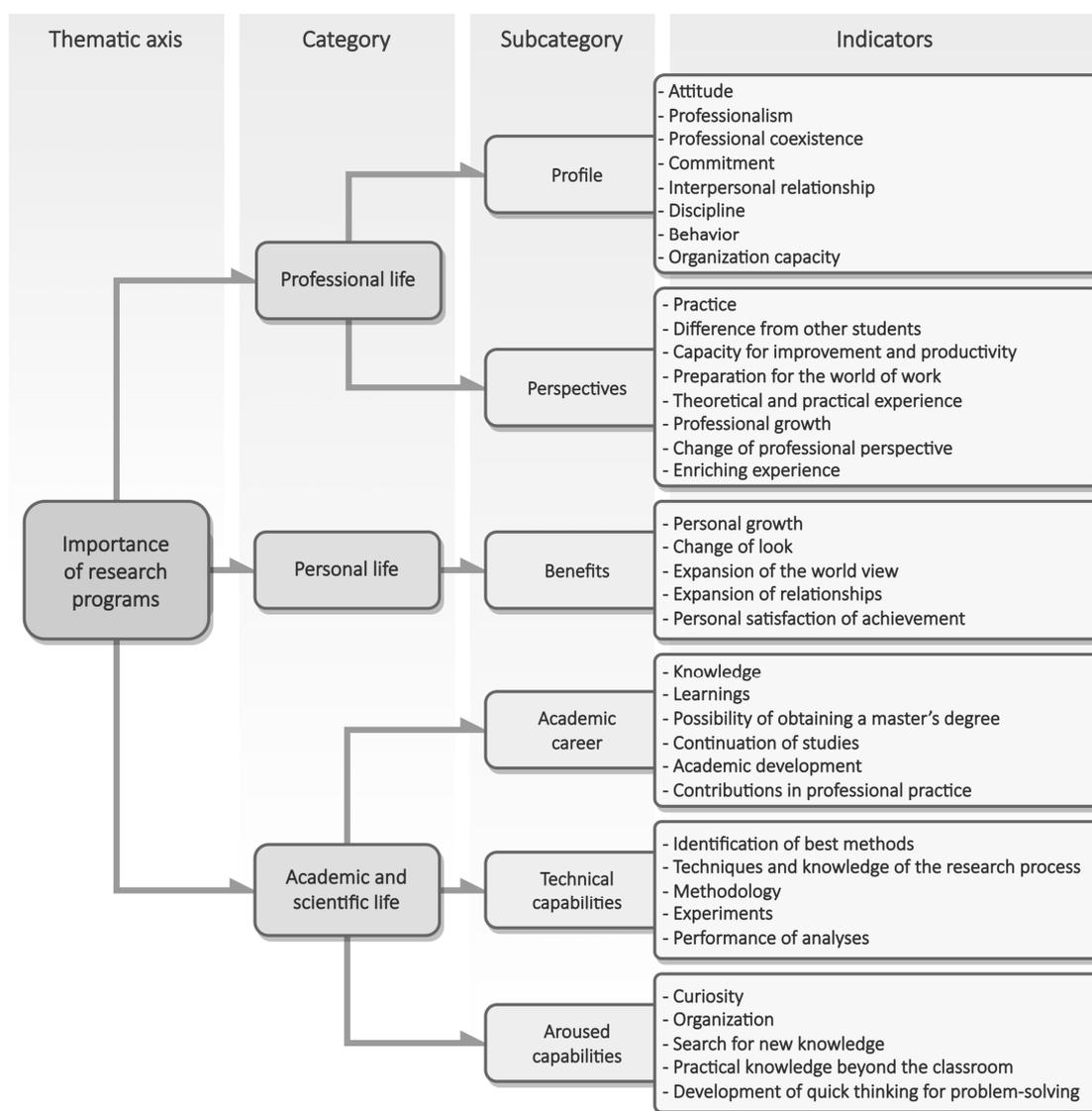


Figure 2. Thematic analysis of the students: perceptions about importance of research programs in undergraduate research projects with a focus on student–supervisor collaboration.

The items addressing the importance of research programs included multiple dimensions of students’ professional, personal, academic, and scientific lives; therefore, each thematic axis was categorized and subcategorized. Among the various aspects identified by the interviews, in the professional life category, interviewee S1 talked about the impact of scientific research experience during undergraduate studies and beyond.

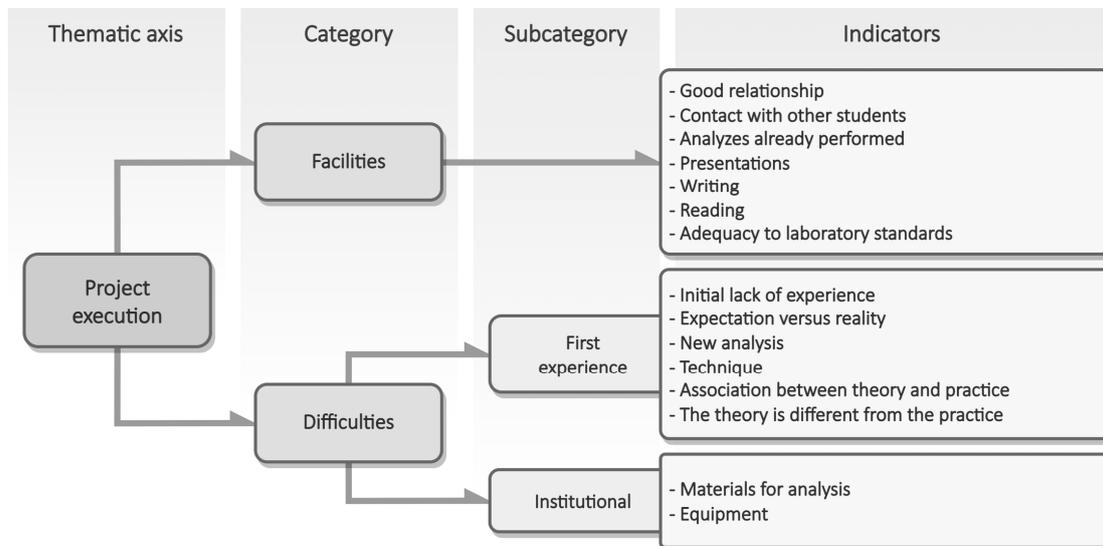


Figure 3. Thematic analysis of the students: perceptions about project execution.

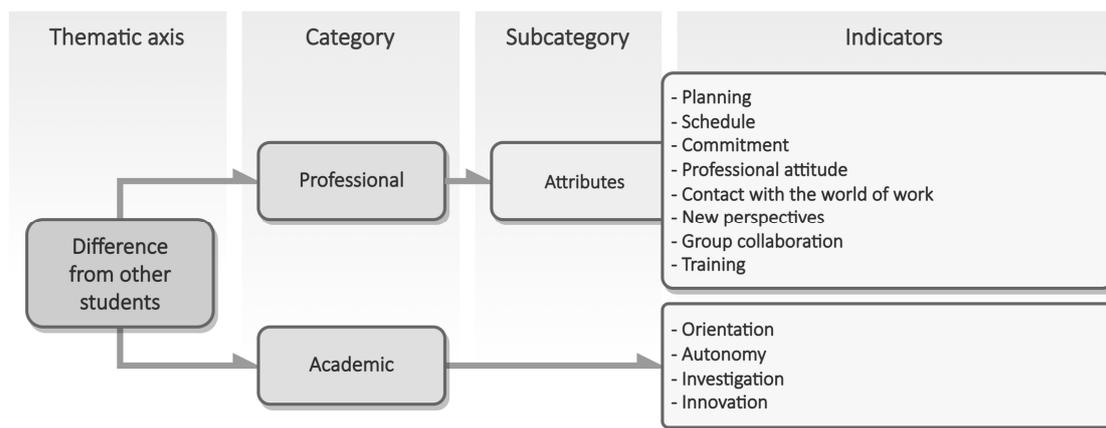


Figure 4. Thematic analysis of the students: perceptions about difference from other students.

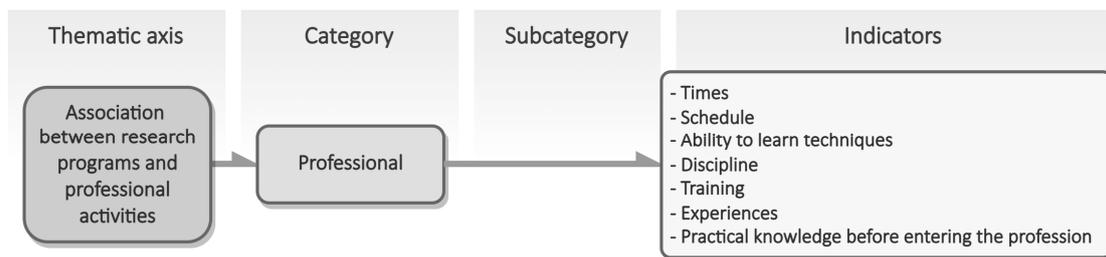


Figure 5. Thematic analysis of the students: perceptions about association between research programs and professional activities.

It is like . . . you get even more organized because we work at a professional level right there. You must organize your own schedule, define the approach for their experiments, be available, be punctual, arrive on time, and then you start to interact with people more frequently, both professionally and even socially, you know, making friends. Thus, [scientific research] is an advantage not only in the professional, but also in the social life. (S1)

Interviewee S4 indicated several benefits of scientific research in the personal life category. His discourse shows how the experience of scientific research can transform and serve as a foundation for the future.

My experience with PIBIC was something that completely changed me as a person. Being part of a program like undergraduate research simply changed my whole outlook, my career, my professional and academic perspective in every way during graduate studies because it helped me to have a vision that I did not have before. Even the disciplines made me grow a lot and enable me to learn, meet people, visit places, which was incredible for me. (S4)

Continuing this thematic axis, the students reported that their experience in research programs prepares an individual for life. They also stated that it increased their likelihood of continuing their studies, possibly pursuing a master's degree and doctorate. Moreover, they learned how to identify the best methods, perform analyses, interpret results, and solve problems.

We found both facilities and difficulties in the thematic axis "project execution". As for facilities, we can conclude that those students who participated in scientific research more than once obtained knowledge from analyses already performed and had better performance in presentations, writing, and reading. The discourses revealed that students participating for the first time experienced considerable difficulty in facilities. The main challenges reported were the initial lack of experience among students who had recently joined the undergraduate program in dealing with scientific research and the separation of theory and practice.

Although there are difficulties, S4, in the thematic axis "difference from other students" (i.e., who did not have UR experience), refers to research as an educational principle.

I think that only the classroom can bring knowledge, but not in the same practical and experiential way enabled by research. When conducting research, you are the subject of learning, constructing your own knowledge with the help of a person who is there to help you along the way; you have great autonomy to grow differently. You are the one producing that, you are building that knowledge and building it with other people, with other researchers. (S4)

Qualities found in the academic environment that can be transferred to work were also identified in the thematic axis "association between research programs and professional activities", including being punctual, establishing a schedule, and putting techniques learned during undergraduate studies into practice.

[. . .] I think I will be able to work in the development of new products and the area of food analysis when I graduate. [. . .]. So, we already have . . . at least a little bit, we are not going to the market 100% prepared, but we have a good notion, I think, so we can go there and say 'ah! I made it!' We learn a lot more by practicing than simply reading in the classroom. There, we are getting our hands dirty, so we learn a lot more. (S6)

The following thematic axis was assigned to the advisors: students' perceptions (Figure 6). The advisors reported both personal, academic, and scientific aspects when describing their profiles.

[. . .] The most similar aspect among them is that they have a close relationship with a professor. So, they like that professor more than the others and look for that professor to develop a project. Alternatively, a professor perceives that a student stands out in a specific area due to their empathy, responsibility, dedication, or grade and invites them to participate in the project. (A3)

I believe that the profile of a student of undergraduate research is already defined even before they join the research program; they are characterized by being objective and knowing what they want, and being concerned even with their future. They are not only concerned with their current activities within the institution as a student, but also with

what they will become in the future, so these students have a scientific profile that is aligned to the objectivity required by research. (A1)

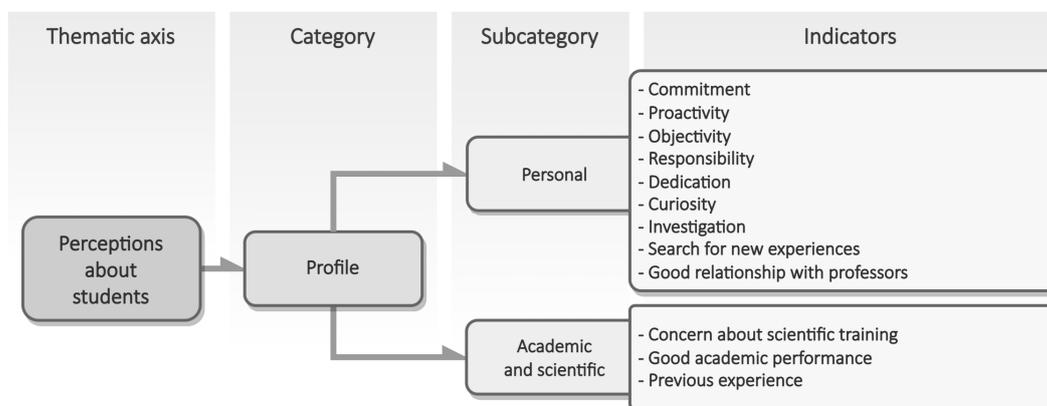


Figure 6. Thematic analysis of the advisors: perceptions.

4. Discussion

The findings of this study indicate the following: for a predominance of young researchers, either in relation to the students' or advisors' groups, mostly in Agrarian Sciences; two or more cycles in research programs can improve students' scientific production indicators, if the student is well guided by his advisor; and both students and advisors consider the research experience positive. The two also agree on the importance of the experience, learning, and questions on the future of the students who undergo this experience.

According to the findings of our study, most Brazilian supervisors working in research programs were between 33 and 38 years old. Therefore, we can deduce that they are still young supervisors and that they have some experience acquired in scientific research. Although they still have a lot to learn from practical experience, because they are young, they have the vitality to deal with more complex research that demands a lot of dedication.

A previous study investigated the profiles of undergraduate students in an undergraduate course and found that students, mostly female, joined research projects before 25 years of age [45]. Our study corroborates, in part, with the data obtained by this study. Our findings indicate that 88.3% of the participants were aged between 19 and 24 years. However, we did not identify a significant sex predominance in relation to the group of students or in relation to the students' or advisors' groups. In this perspective, it emphasizes that a balanced representation of genders is necessary to break paradigms [46] and influence equity, social justice, talent, socioeconomic development, and competitiveness [47].

The panel of institutional programs for scientific and technological initiation of *CNPq*, updated until July 2017, includes data from all states in Brazil, including the Distrito Federal. The data from this panel show that the field of knowledge was Agrarian Sciences, this field appears between the first and third place in some research programs [48]. In our findings, however, this area of research was the most prevalent, due to the origin and predominant agricultural vocation of the campuses of the *IF Goiano*. From this perspective, our data confirm the results of a previous study that found Agricultural Sciences (36.1%) was the most researched area among research projects funded by *PIBIC* [49].

Writing a scientific text is not an easy task and involves a series of skills, requiring mastery of language and technical-scientific knowledge, in addition to knowledge of various techniques [50]. Although the scientific production of some students was greater than others without experience in UR, the positive impact of participating in UR in relation to this production is perceptible. The average number of articles, abstracts, books, chapters, or patents produced by students who participated for the first time did not reach one. Undergraduate students can increase their scientific production more significantly after one year [51]. At first, they are usually concerned with the conduct of the experiment, and later, with the investigation, techniques, data collection, interpretation, and new research

questions [52]. From this perspective, students who participated in the research program multiple times had significantly higher scientific production (scientific articles, scientific articles in English, expanded abstracts, and simple abstracts) than those who participated only once ($p < 0.001$). On the other hand, if we compare all the productions of students who participated in one cycle with those who engaged in two or more cycles, the average increased more than five times, that is, it went from 2.10 to 11.38 productions per student.

A study with first-year biology students at the University of Western Australia included a research-based experiment, in which students described their scientific results, reviewed their peers' articles, and some were published. This study found that student involvement in the topic under investigation increased significantly after data collection and analysis [53]. Writing the results and presenting the work are essential activities for students who act as researchers. These activities are stimulated through internal events, external events, and financial support to publish scientific articles in international publications.

Regarding contact with foreign languages in academic contexts (i.e., reading, interpretation, and writing scientific texts in foreign languages), when asked whether scientific research activities instigated the student's contact with foreign languages, there was a significant difference between the responses of students and supervisors. Students marked this question as indifferent, partially agree, or totally disagree more (increment of 18.3%) than did the advisors, revealing a gap between scientific progress and the internationalization of Brazilian science. Furthermore, the scientific production of articles written in English averaged 0.03 for students who were experiencing UR for the first time and 0.52 for students who participated two or more times. In this regard, a recent study on disadvantages in the preparation and publication of scientific articles due to the mastery of the English language in science mentioned the case of Colombian researchers in the field of Biological Sciences [54]. This country has one of the lowest levels of English proficiency in the world, making it difficult to publish articles and read and write texts in English [54]. It is undeniable that practical activities can help students better understand scientific writing. From this perspective, another study on this subject conducted with UR students revealed that one of the initial barriers to publication is knowing each section of the article; based on this assumption, meetings were held to discuss and practice in groups to promote an understanding of the topic, and the activities were well accepted and reported to be positive [55]. Thus, in addition to mastering the international language of science, they concluded that learning about each section of an article is essential for improving the writing of that article [55]. To finalize this issue, one must also consider that Brazil is in position 53 and is classified as having low proficiency [56], as pointed out by the Education First English Proficiency Index (EF EPI). This rank, maintained by this international company, is calculated based on countries' proficiency indices through English tests. This information can help UR students understand the low indicators of scientific articles written in English and, mainly, can help advisors who will be able to adopt more effective strategies to guide their mentees.

In our study, the supervisors' perceptions of students highlight that those students who engage in scientific training, as a result of this, are those with the best academic performance. According to a study on the benefits of UR, it was found that these students were generally those with the highest grades and who were most likely to continue their studies [11]. In addition, the benefits of UR experience can be categorized as personal and professional benefits, including greater confidence, behaving as a scientist, better career preparation, and changes in attitudes toward learning and working as a researcher [57].

In relation to the advantage over other students, some indicators were pointed out, such as: group collaboration, autonomy, and improvement in investigation capacity. A study on the development and assessment of the research experience in undergraduate studies showed characteristics similar to those observed in our study: collaboration, autonomy, problem-solving ability, and ability to perform tasks [9].

Students indicated they intend to continue their studies in their academic careers, i.e., to pursue a master's degree and doctorate. Thus, our findings corroborate with another

study conducted in the United States, which found that students who participated in UR were up to four times more likely to be accepted into a graduate program than students who did not have this experience [58]. By engaging in UR, students can align their short or long-term goals related to their future prospects, motivated by the utilitarian value of their research experience [59]. Thus, it is clear that participation in scientific research programs can greatly influence and direct students to continue their academic careers and can influence the construction of scientific identity [59].

One of the limitations of our study is that it was conducted in only one educational institution in Brazil. Moreover, while our study focused on the experiences and perceptions of students and their supervisors in UR projects, we recognize, as a limitation of our study, the possibility of other factors contributing to successful collaboration and networking within these programs. Additionally, a more in-depth analysis of the role of supervisors, associated factors, and their impact on student success could be valuable for the formulation of more effective public policies. A strong point of this study is its mixed approach, using both quantitative and qualitative data, which allowed a better understanding of the scientific research experience. These data can help develop strategies to increase scientific production and detect limitations that require actions aimed at improvement.

Finally, we highlight the importance of carrying out future studies which should include other educational institutions in Brazil or even internationally. Thus, we could compare our findings with the perceptions of students and supervisors regarding experiences in other research programs. Scientific production should also be further explored, considering that the purpose of these programs is to initiate research through a project. Among other aspects, this process aims to disseminate scientific knowledge through the works carried out. With this, we would be contributing to the formation of high-level human resources that, in turn, could act as agents of change to face the future challenges of society [49]. From this perspective, our study serves as a starting point for future investigations into the effectiveness of research programs in undergraduate and other levels of education, such as high school.

5. Conclusions

The main findings of this study indicate that scientific research conducted through institutional programs has fulfilled its purpose of training quality human resources. The perception of students and advisors about the research experience during the school period was recognized as positive. It contributes to constructing professional identities endowed with several skills and promotes development in the personal and social spheres. It is worth mentioning that this development process is not limited to students; it also includes advisors who, by mediating learning, also improve their practices, especially if they periodically reflect on their actions and knowledge.

Moreover, some indicators of the scientific production of students can be improved. The averages of books and patents, for example, were below one, even when the students participated two or more times in the programs. The writing of abstracts and articles in Portuguese or a foreign language should also be encouraged by the advisor. Finally, students, advisors, and institutions were engaged in research, opening space for the strengthening of science in the lives of young researchers.

Therefore, we argue that the integration of forces and efforts in favor of scientific activity can contribute to education to promote integral development. Contact with science promotes multiple experiences that surpass the theory and practice dichotomy, from which social transformation can be favored through the transformation of consciences. Concomitantly, students and supervisors involved in UR develop even more, which reverberates not only in the academic sphere but also in society's (re)construction.

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and M.N.; Supervision, P.R.E.S.N. and M.N.; Validation, A.F.M., L.d.A.C.B.N. and M.N.; Visualization: A.F.M., W.P.d.C. and M.N.; Writing—original draft preparation, A.F.M., W.P.d.C., R.R.R., L.d.A.C.B.N., P.R.E.S.N. and M.N.; Writing—review and editing, A.F.M., W.P.d.C., R.R.R., L.d.A.C.B.N., P.R.E.S.N. and M.N. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study, through the respective ICF, in compliance with the provisions of Resolution CNS no. 510/2016, of the Brazilian National Health Council (*Conselho Nacional de Saúde—CNS*). This legislation is applicable to research in Human and Social Sciences [60]. The research design was approved by the *IF Goiano* Research Ethics Committee (*CEP*—protocol no. 08499119.9.0000.0036).

Data Availability Statement: The data are not publicly available due to ethical restrictions, in accordance with Brazilian legislation (Resolution CNS no. 510/2016).

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Questionnaire for undergraduate students

Dear Student,

You are being invited to participate as a volunteer in the research that aims to evaluate the profile, academic production and evolution of students linked to the Undergraduate Programs.

The data will be used only for the purpose of the research, maintaining secrecy and confidentiality of the respondent, therefore, your answer will not be identified.

Your contribution will be of great importance for the realization of this study.

Thank you for your participation and support in this research!

Do you agree to participate in this research?

- Yes No

Thank you for agreeing to participate in this survey! Below are the questions.

BLOCK 1: About your profile.

1. What is your date of birth?

2. What is your sex?

- Female Male

3. What is your color/ethnicity?

- White Mixed Indigenous
 Black Yellow I don't wish to answer

4. Which campus are you a student at?

- Campos Belos Cristalina Iporá Rio Verde
 Catalão Hidrolândia Morrinhos Trindade
 Ceres Ipameri Posse Urutá

5. What graduation course are you enrolled in?

6. Which program did you take part in from 2018 to 2019?

- PIBIC PIBITI
 PIVIC PIVITI

7. Was this the first time you participated in undergraduate research or technological development programs?

- Yes No

8. Do you intend to continue participating in undergraduate research or technological development programs?

- Yes No I can't say

BLOCK 2: Do you consider that participating in a project of the undergraduate research or the technological development programs ...

9. ... how was your evolution during the research period?
- Very good
 - Good
 - Fair
 - Poor
 - Very poor
10. ... was important during your undergraduate studies?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
11. ... sparked your interest in research?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
12. ... added knowledge?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
13. ... developed your critical thinking?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
14. ... stimulated your creativity?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
15. ... made you more responsible?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
16. ... helped the organization to carry out the planned activities within the deadline?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
17. ... made you acquire knowledge, learning about research methods and techniques?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree

18. . . . aroused your interest in scientific writing?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
19. . . . encouraged you in the oral presentations of works?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
20. . . . your academic performance will be better in postgraduate program due to this experience?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
21. . . . could help you in any way to get a good job in the future?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
22. . . . encouraged you to have contact with foreign languages (e.g.,: English, Spanish)?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
- BLOCK 3:**
23. Do you consider that the *IF Goiano* supports scientific research activities such as undergraduate research or technological development programs?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
24. What is your level of satisfaction after the end of the term of your research activities?
- Very satisfied
 - Satisfied
 - Reasonably satisfied
 - Dissatisfied
 - Very unsatisfied
25. Which of the options represents how was your relationship with your project advisor?
- Very good
 - Good
 - Fair
 - Poor
 - Very poor
26. Have you and your supervisor published the results of the project? (mark as many as needed)
- Yes, in a national or international magazine
 - Yes, in national or international event annals
 - No, we don't publish and do not intend to publish
 - No, we don't publish but we intend to publish in national or international event annals
 - No, we don't publish but we intend to publish in a national or international journal
27. Did you write abstracts and articles?
- Yes
 - No
28. Is your curriculum on the Lattes platform up to date?
- Yes
 - No

Appendix B

Questionnaire for supervisors

Dear Supervisor,

You are being invited to participate as a volunteer in the research that aims to evaluate the profile, academic production and evolution of students linked to the Undergraduate Programs.

The data will be used only for the purpose of the research, maintaining secrecy and confidentiality of the respondent, therefore, your answer will not be identified.

Your contribution will be of great importance for the realization of this study.

Thank you for your participation and support in this research!

Do you agree to participate in this research?

Yes No

Thank you for agreeing to participate in this survey! Below are the questions.

BLOCK 1: About your profile.

1. What is your date of birth?

2. What is your sex?

Female Male

3. What is your color/ethnicity?

White Mixed Indigenous
 Black Yellow I don't wish to answer

4. Which Campus of IF Goiano do you have a link to?

Campos Belos Cristalina Iporá Rio Verde
 Catalão Hidrolândia Morrinhos Trindade
 Ceres Ipameri Posse Urutaí

5. What is the main area of knowledge of your education?

Agrarian Sciences Humanities
 Biological Sciences Applied Social Sciences
 Health Sciences Engineering
 Exact and Earth Sciences Linguistics, Languages, and Arts

6. Which program did you act as a supervisor in from 2018 to 2019? (mark as many as needed)

PIBIC-EM PIBIC PIBITI
 PIVIC-EM PIVIC PIVITI

7. How many students did you supervise in the undergraduate research and technological development programs from 2018 to 2019?

8. Do you intend to continue advising students in undergraduate research and technological development programs?

Yes No I can't say

BLOCK 2: Do you consider that by participating in a project of the undergraduate research or the technological development programs ...

9. ... how do you rate the evolution of your advisees during the term 2018 to 2019?

Very good
 Good
 Fair
 Poor
 Very poor

10. ... are important for the participation the students of high school and undergraduate students in scientific research projects or the technological development programs?

Totally agree
 Partially agree
 Indifferent
 Partially disagree
 Totally disagree

11. ... awaken students' interest in research?

Totally agree
 Partially agree
 Indifferent
 Partially disagree
 Totally disagree

-
12. . . . add knowledge to students?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
13. . . . develop critical thinking of students?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
14. . . . stimulate creativity of students?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
15. . . . make students more responsible?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
16. . . . help students to better organize themselves to fulfill the planned activities within the deadline?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
17. . . . help students gain knowledge and learning about methods and techniques of research?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
18. . . . awaken students' interest in scientific writing?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
19. . . . encourage students to present work orally?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree
20. . . . allow students to perform better in postgraduate studies due to this experience?
- Totally agree
 - Partially agree
 - Indifferent
 - Partially disagree
 - Totally disagree

21. . . . allow students to get a prestigious job in the future than others who haven't had this experience?

- Totally agree
- Partially agree
- Indifferent
- Partially disagree
- Totally disagree

22. . . . encourage students to have contact with foreign languages?

- Totally agree
- Partially agree
- Indifferent
- Partially disagree
- Totally disagree

BLOCK 3:

23. Do you consider that the *IF Goiano* supports scientific research activities such as undergraduate research or technological development programs?

- Totally agree
- Partially agree
- Indifferent
- Partially disagree
- Totally disagree

24. What is your level of satisfaction after the end of the 2018 to 2019 term?

- Very satisfied
- Satisfied
- Reasonably satisfied
- Dissatisfied
- Very unsatisfied

25. How do you evaluate your relationship with your mentees in the period from 2018 to 2019?

- Very good
- Good
- Fair
- Poor
- Very poor

26. Have you and your mentees published the results of the project? (mark as many as needed)

- Yes, in a national or international magazine
- Yes, in national or international event annals
- No, we don't publish and do not intend to publish
- No, we don't publish but we intend to publish in national or international event annals
- No, we don't publish but we intend to publish in a national or international journal

27. Have you submitted any products for patent registration from student projects during this term?

- Yes
- No

28. Do you believe that the activities carried out in research projects and/or technological development programs (*PIBIC*, *PIBIC-EM* and *PIBITI*) contribute to your scientific publications?

- Yes
- No

Appendix C

Interview script with undergraduate students

You are being invited to participate, as a volunteer, in the research.

Your participation consists of answering questions from which information will be extracted that will be used for the scientific publication.

In case of doubt, you can contact the researcher by e-mail.

Thanks in advance for your support!

Do you agree to participate in this research?

- I agree to participate in the research
- I don't agree to participate in the research

Thank you for agreeing to participate in this interview!

1. Was it the first time you were linked to the program and do you recommend this experience to others?
2. What have you learned this term?
3. What were your greatest facilities during the development of your research project? And the main difficulties?
4. Do you believe that CI is important for your future? Why?
5. Do you believe that having participated in IC during graduation is a differential from other students? Why?
6. Do you notice any kind of association between the activities developed in Scientific Initiation and professional activities?
7. Do you have any kind of suggestion or criticism to make about Scientific Initiation in general (Institute, advisor, other students, etc.)?

Appendix D

Interview script with supervisors

You are being invited to participate, as a volunteer, in the research.

Your participation consists of answering questions from which information will be extracted that will be used for the scientific publication.

In case of doubt, you can contact the researcher by e-mail.

Thanks in advance for your support!

Do you agree to participate in this research?

- I agree to participate in the research
- I don't agree to participate in the research

Thank you for agreeing to participate in this interview!

1. Is there a program presentation meeting held at the beginning of the term to instruct students? If so, what subjects are covered?
2. How do you describe the profile of students enrolled in these Programs?
3. How would you describe the profile of the advisors?
4. Do you believe that Scientific Initiation and Technological Development activities contribute to publications by advisors and students?
5. Do you consider that the Institution supports scientific research activities?
6. What are the main challenges encountered in coordinating the Scientific Initiation and Technological Development Programs?
7. What are the main challenges encountered in coordinating the Scientific Initiation and Technological Development Programs?

References

1. CNPq. *Normative Resolution no 17/2006: Quota Scholarships in the Country*; CNPq: Brasília, Brazil, 2006. Available online: http://memoria2.cnpq.br/view/-/journal_content/56_INSTANCE_0oED/10157/100352?COMPANY_ID=10132 (accessed on 15 January 2023).
2. National Research Council. *Scientific Research in Education: Committee on Scientific Principles for Education Research*; Shavelson, R.J., Towne, L., Eds.; The National Academies Press: Washington, DC, USA, 2002. [CrossRef]
3. Robnett, R.D.; Chemers, M.M.; Zurbriggen, E.L. Longitudinal associations among undergraduates' research experience, self-efficacy, and identity. *J. Res. Sci. Teach.* **2015**, *52*, 847–867. [CrossRef]
4. Banger, G.; Brownell, S.E. Course-based undergraduate research experiences can make scientific research more inclusive. *CBE-Life Sci. Educ.* **2014**, *13*, 602–606. [CrossRef] [PubMed]
5. Harsh, J.A.; Maltese, A.V.; Tai, R.H. A perspective of gender differences in chemistry and physics undergraduate research experiences. *J. Chem. Educ.* **2012**, *89*, 1364–1370. [CrossRef]
6. Lopatto, D. Survey of Undergraduate Research Experiences (SURE): First findings. *Cell Biol. Educ.* **2004**, *3*, 270–277. [CrossRef] [PubMed]
7. Schultz, P.W.; Hernandez, P.R.; Woodcock, A.; Estrada, M.; Chance, R.C.; Aguilar, M.; Serpe, R.T. Patching the pipeline. *Eval. Policy Anal.* **2011**, *33*, 95–114. [CrossRef]
8. CGEE. *The formation of new staff for CT&I: Evaluation of the Institutional Program of Scientific Initiation Scholarships (PIBIC)*; Athalaia: Brasília, Brazil, 2017. Available online: <https://www.gov.br/cnpq/pt-br/centrais-de-conteudo/publicacoes/3pibic-pdf> (accessed on 16 January 2023).

9. Olimpo, J.T.; Fisher, G.R.; DeChenne-Peters, S.E. Development and evaluation of the tigrionus course-based undergraduate research experience: Impacts on students' content knowledge, attitudes, and motivation in a majors introductory biology course. *CBE-Life Sci. Educ.* **2016**, *15*, 1–15. [CrossRef]
10. Heras, M.; Ruiz-Mallén, I. Responsible research and innovation indicators for science education assessment: How to measure the impact? *Int. J. Sci. Educ.* **2017**, *39*, 2482–2507. [CrossRef]
11. Russell, S.H.; Hancock, M.P.; McCullough, J. Benefits of undergraduate research experiences. *Science* **2007**, *316*, 548–549. [CrossRef]
12. Cooper, K.M.; Gin, L.E.; Akeeh, B.; Clark, C.E.; Hunter, J.S.; Roderick, T.B.; Elliott, D.B.; Gutierrez, L.A.; Mello, R.M.; Pfeiffer, L.D.; et al. Factors that predict life sciences student persistence in undergraduate research experiences. *PLoS ONE* **2019**, *14*, 1–30. [CrossRef]
13. Hunter, A.-B.; Laursen, S.L.; Seymour, E. Becoming a scientist: The role of undergraduate research in students' cognitive, personal, and professional development. *Sci. Educ.* **2007**, *91*, 36–74. [CrossRef]
14. Mahatmya, D.; Morrison, J.; Jones, R.M.; Garner, P.W.; Davis, S.N.; Manske, J.; Berner, N.; Johnson, A.; Ditty, J. Pathways to undergraduate research experiences: A multi-institutional study. *Innov. High. Educ.* **2017**, *42*, 491–504. [CrossRef]
15. Thiry, H.; Weston, T.J.; Laursen, S.L.; Hunter, A.-B. The benefits of multi-year research experiences: Differences in novice and experienced students' reported gains from undergraduate research. *CBE-Life Sci. Educ.* **2012**, *11*, 260–272. [CrossRef]
16. Zydney, A.L.; Bennett, J.S.; Shahid, A.; Bauer, K.W. Impact of undergraduate research experience in engineering. *J. Eng. Educ.* **2002**, *91*, 151–157. [CrossRef]
17. Mabrouk, P.A. Survey study investigating the significance of conference participation to undergraduate research students. *J. Chem. Educ.* **2009**, *866*, 1335–1340. [CrossRef]
18. Behar-Horenstein, L.S.; Roberts, K.W.; Dix, A.C. Mentoring undergraduate researchers: An exploratory study of students' and professors' perceptions. *Mentor. Tutoring: Partnersh. Learn.* **2010**, *18*, 269–291. [CrossRef]
19. Brownell, S.E.; Hekmat-Safe, D.S.; Singla, V.; Seawell, P.C.; Imam, J.F.C.; Eddy, S.L.; Stearns, T.; Cyert, M.S. A high-enrollment course-based undergraduate research experience improves student conceptions of scientific thinking and ability to interpret data. *CBE-Life Sci. Educ.* **2015**, *14*, ar21. [CrossRef]
20. Droscher, F.D.; da Silva, E.L. The researcher and scientific production. *Perspect. Em Ciênc. Da Inf.* **2014**, *19*, 170–189. [CrossRef]
21. Cabrero, R.D.C.; Costa, M.D.P.R. Scientific Initiation, scientific initiation scholarship and research groups. In *Scientific Initiation: Historical, Organizational, and Formative Aspects of the Activity in Brazilian Higher Education*, 1st ed.; Massi, L., Queiroz, S.L., Eds.; UNESP: São Paulo, Brazil, 2015; pp. 109–129. [CrossRef]
22. Amaya, L.R.; Betancourt, T.; Collins, K.H.; Hinojosa, O.; Corona, C. Undergraduate research experiences: Mentoring, awareness, and perceptions—A case study at a Hispanic-serving institution. *Int. J. STEM Educ.* **2018**, *5*, 9. [CrossRef]
23. CNPq. National Council for Scientific and Technological Development—CNPq: The Creation. 2017. Available online: <http://memoria.cnpq.br/a-criacao> (accessed on 15 January 2023).
24. Pires, R.C.M. Initial training of research professors through the PIBIC/CNPq Program: What does the professional practice of graduates tell us? *Eval. High. Educ. Eval. Mag.* **2009**, *14*, 487–514. [CrossRef]
25. Massi, L.; Queiroz, S.L.; Dinham, R. Studies on Scientific Initiation in Brazil: A review. *Res. Noteb.* **2010**, *40*, 173–197. [CrossRef]
26. Smith, J.L.; Deemer, E.D.; Thoman, D.B.; Zazworsky, L. Motivation under the microscope: Understanding undergraduate science students' multiple motivations for research. *Motiv. Emot.* **2014**, *38*, 496–512. [CrossRef]
27. Galvão, T.; Noll, P.R.E.S.; Noll, M. Perceptions, relationships, expectations, and challenges: Views of communication and research for scientific dissemination in Brazilian Federal Institutes. *PLoS ONE* **2021**, *16*, 1–20. [CrossRef] [PubMed]
28. Yin, R.K. *Case Study Research and Applications: Design and Methods*, 6th ed.; SAGE Publications: Los Angeles, CA, USA, 2017.
29. Creswell, J.W.; Clark, V.L.P. *Designing and Conducting Mixed Methods Research*, 3rd ed.; SAGE Publications: Los Angeles, CA, USA, 2017.
30. Brazil. Nilo Peçanha Platform. 2019. Available online: <https://www.gov.br/mec/pt-br/pnp> (accessed on 2 February 2023).
31. Baqui, P.; Bica, I.; Marra, V.; Ercole, A.; van der Schaar, M. Ethnic and regional variations in hospital mortality from COVID-19 in Brazil: A cross-sectional observational study. *Lancet Glob. Health* **2020**, *8*, e1018–e1026. [CrossRef] [PubMed]
32. IBGE *Social Inequalities by Color or Race in Brazil: Technical Notes*, 2nd ed.; Report No.: 48; IBGE: Rio de Janeiro, Brazil, 2022. Available online: <https://biblioteca.ibge.gov.br/index.php/biblioteca-catalogo?view=detalhes&id=2101972> (accessed on 20 February 2023).
33. Hermida, P.M.V.; Araújo, I.E.M. Elaboration and validation of the nursing interview instrument. *Braz. J. Nurs.* **2006**, *59*, 314–320. [CrossRef]
34. Alexandre, N.M.C.; Coluci, M.Z.O. Content validity in the processes of construction and adaptation of measurement instruments. *Public Sci. Health* **2011**, *16*, 3061–3068. [CrossRef]
35. Likert, R. A technique for the measurement of attitudes. *Arch. Psychol.* **1932**, *22*, 5–55.
36. Khatatbeh, H.; Al-Dwaikat, T.; Oláh, A.; Onchonga, D.; Hammoud, S.; Amer, F.; Prémusz, V.; Pakai, A. The relationships between paediatric nurses' social support, job satisfaction and patient adverse events. *Nurs. Open* **2021**, *8*, 3575–3582. [CrossRef]
37. Da Rosa, B.N.; Candotti, C.T.; Pivotto, L.R.; Noll, M.; Silva, M.G.; Vieira, A.; Loss, J.F. Back pain and body posture evaluation instrument for children and adolescents (BackPEI-CA): Expansion, content validation, and reliability. *Int. J. Environ. Res. Public Health* **2022**, *19*, 1398. [CrossRef]
38. Ugoni, A.; Walker, B.F. The chi square test: An introduction. *COMSIG Rev.* **1995**, *4*, 61–64.

39. Henrique, N.C.P.; Hilário, J.S.M.; Louzada, F.M.; Scorzafave, L.G.D.S.; Santos, D.D.; Mello, D.F. Child sleep habits and maternal perception during the child's first year of life. *J. Hum. Growth Dev.* **2022**, *32*, 321–330. [CrossRef]
40. Hazra, A.; Gogtay, N. Biostatistics series module 3: Comparing groups: Numerical variables. *Indian J. Dermatol.* **2016**, *61*, 251–260. [CrossRef]
41. Fernandes, M.D.S.V.; da Silva, T.M.V.; Noll, P.R.E.S.; de Almeida, A.A.; Noll, M. Depressive symptoms and their associated factors in vocational–technical school students during the COVID-19 pandemic. *Int. J. Environ. Res. Public Health* **2022**, *19*, 3735. [CrossRef]
42. Leitão, F.N.C.; Ferreira, C.R.T.; de Abreu, K.L.; de Deus, M.B.B.; Junior, H.M.; Morais, M.J.D.D. Effects of the social isolation generated by COVID-19 on the quality of life of the population in two Brazilian cities. *J. Hum. Growth Dev.* **2021**, *31*, 405–413. [CrossRef]
43. Bardin, L. *Content Analysis*, 1st ed.; Edições: São Paulo, Brazil, 2016.
44. Dowling, K.; Barry, M.M. Evaluating the implementation quality of a social and emotional learning program: A mixed methods approach. *Int. J. Environ. Res. Public Health* **2020**, *17*, 3249. [CrossRef]
45. Pinto, N.L.D.S.; Fernandes, L.M.A.; Silva, F.F. Beyond academic training: The contributions of Scientific Initiation to the personal and professional development of Business Administration students. *Adm. Teach. Res.* **2016**, *17*, 301–325. [CrossRef]
46. Kerkhoven, A.H.; Russo, P.; Land-Zandstra, A.M.; Saxena, A.; Rodenburg, F.J. Gender stereotypes in science education resources: A visual content analysis. *PLoS ONE* **2016**, *11*, 1–13. [CrossRef]
47. Vázquez-Cupeiro, S. Science, stereotypes, and gender: A review of explanatory frameworks. *J. Soc. Sci.* **2015**, *22*, 68.
48. CNPq. Panel of Institutional Scientific and Technological Initiation Programs. 2017. Available online: <http://estatico.cnpq.br/bi/IndicacaoBolsa/paineis-indicacao-bolsa/painel-dados-painel/index.html> (accessed on 6 February 2023).
49. Noll, M.; Melo, A.F.; Araújo, T.G.; Soares, F.A.L. Profile of scientific initiation students in Brazilian Federal Institutes: Research areas, gender, and scholarship type by region. *Res. Soc. Dev.* **2021**, *10*, 1–14. [CrossRef]
50. Silveira, E.A.; Romeiro, A.M.D.S.; Noll, M. Guide for scientific writing: How to avoid common mistakes in a scientific article. *J. Hum. Growth Dev.* **2022**, *32*, 341–352. [CrossRef]
51. Spronken-Smith, R.; Miroso, R.; Darrou, M. 'Learning is an endless journey for anyone': Undergraduate awareness, experiences and perceptions of the research culture in a research-intensive university. *High. Educ. Res. Dev.* **2014**, *33*, 355–371. [CrossRef]
52. Linn, M.C.; Palmer, E.; Baranger, A.; Gerard, E.; Stone, E. Undergraduate research experiences: Impacts and opportunities. *Science* **2015**, *347*, 1261757. [CrossRef] [PubMed]
53. Mitchell, N.; Triska, M.; Liberatore, A.; Ashcroft, L.; Weatherill, R.; Longnecker, N. Benefits and challenges of incorporating citizen science into university education. *PLoS ONE* **2017**, *12*, 1–15. [CrossRef] [PubMed]
54. Ramírez-Castañeda, V. Disadvantages in preparing and publishing scientific papers caused by the dominance of the English language in science: The case of Colombian researchers in biological sciences. *PLoS ONE* **2020**, *15*, 1–15. [CrossRef] [PubMed]
55. Melo, A.F.; Felício, C.M.; Ferreira, J.C.; Noll, M. The effect of practical activities on Scientific Initiation students' understanding of the structure of scientific articles: An experience report. *Int. J. Teach. Learn. High. Educ.* **2020**, *32*, 367–375.
56. EF Education. EF EPI 2018 Reports: English proficiency index—Europe. 2018. Available online: <https://www.ef.com.br/epi/downloads/> (accessed on 16 February 2023).
57. Seymour, E.; Hunter, A.-B.; Laursen, S.L.; DeAntoni, T. Establishing the benefits of research experiences for undergraduates in the sciences: First findings from a three-year study. *Sci Educ.* **2004**, *88*, 493–534. [CrossRef]
58. Hernandez, P.R.; Woodcock, A.; Estrada, M.; Schultz, P.W. Undergraduate research experiences broaden diversity in the scientific workforce. *Bioscience* **2018**, *68*, 204–211. [CrossRef]
59. Ceyhan, G.D.; Tillotson, J.W. Early year undergraduate researchers' reflections on the values and perceived costs of their research experience. *Int. J. STEM Educ.* **2020**, *7*, 1–19. [CrossRef]
60. Brazil; Resolution CNS no 510/2016: Provides for Ethical Norms Applicable to Brazilian Research in Human and Social Sciences; Brazilian National Health Council: Brasília, Brazil, 2016. Available online: https://www.in.gov.br/materia/-/asset_publisher/Kujrw0TZC2Mb/content/id/22917581 (accessed on 17 January 2023).

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