THE USE OF MOBILE LEARNING IN THE PROFESSIONAL MASTER'S DEGREE IN CYBERSECURITY

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ABSTRACT

Cybersecurity in Brazil and around the world has expanded due to the majority use of the world wide web through Information and Communications Technology (ICTs). In the educational field, the use of mobile devices during the COVID-19 pandemic was the common tool both students and teachers found to facilitate studies once the lockdown and the social distancing came into force, and remote teaching was adopted and implemented by universities. Notably, the Professional Graduate Program in Electrical Engineering (PPEE), at the University of Brasília (UnB), has a professional postgraduate program that aims to train its students in that cybersecurity—using mobile learning as one of its learning tools—which is relevant to public and private institutions.

1. INTRODUCTION

Currently, when we consider the high availability of access to global computer networks and the various information and communications technologies (ICTs), the digital world has exponentially grown—according to the International Telecommunication Union (ITU), in 2021, the number of global internet users reached 4,9 billion, which accounts for 63% of the world population (ITU, 2021)—encompassing, and developing the structure of several private and governmental entities. Conversely, the training of qualified professionals in the data protection and cybersecurity field has not followed this growth—in other words, the lack of qualified professionals creates breaches for cyber-attacks. According to the Security Report, Brazil was the 5th country with most of the cyber-attacks in the world, which brought financial losses to establishments as well as to their users.

Educational tools and strategies have also been redefined by ICTs, especially from 2020 onwards, when we had to adopt social distancing protocols due to the COVID-19 pandemic outbreak, and because of that, face-to-face activities were suspended to reduce the virus transmission. Educational activities were also suspended for a certain period of time, returning only remotely so that the damage was reduced as much as possible.

The dramatic increase of the use of easy-to-handle mobile devices—such as smartphones, tablets, laptops, and e-readers, for example—with the fifth generation of mobile network (5G) provides the student with a collaborative learning network, making it possible for them to experience new learning situations.

According to Al-Emran et al. (2018), mobile learning (M-learning) provides access to information, educational resources, and learning tools to students anytime and anywhere, and the learning process is not limited to a specific place (Corbeil & Valdes-Corbeil, 2007, as cited in Biswas et al). In addition, M-learning empowers and facilitates the shared knowledge in the teaching-learning process between learners and educators, bringing several opportunities for both without imposed restrictions (Al-Emran et al., 2020).

Encouraging the use of new technologies in the pedagogical scenario, by students and professors, within formal university learning had already been identified as a necessity (Bauer et al., 2020), nevertheless, it can be said that this use was propelled due to the pandemic with the implementation of remote teaching. And because of its greater scope and reach, reduced costs, and flexibility for the student to be able to balance study

and private life; remote teaching has, therefore, contributed to the qualification of professionals (Maia & Meirelles, 2009).

Considering the challenges of cybersecurity and the need for courses on the subject at hand, our paper presents the experience of the Cybersecurity course—presently provided by the Professional Graduate Program in Electrical Engineering (PPEE) of the University of Brasília (UnB), in Brazil—during the years 2020-2021. The PPEE of UnB is developed by the Department of Electrical Engineering (ENE) of the Faculty of Technology (FT), and is ruled, where applicable, by the current legislation, as established by the provisions of the National Council of Education (CNE), by the Statute and General Regulations of the University of Brasília and by the Resolutions of the Teaching, Research and Extension Council (CEPE) nos. 0098/2020, 0080/2021, and 217/2016.

Our objective is to carry out a survey of the contributions that a Professional Training Program in Cybernetic Security can add to the training of qualified professionals and what is its impact on the labour market. And, also, we want to present to other graduate programs the methods and techniques supported by mobile technologies used by our PPEE, opening a communication network for dialogues about innovation between ours and graduate programs. Despite being a case study, the survey we herein conducted is instrumental in obtaining innovative alternatives and possibilities so that it is possible to increase the discussions on the capacity of the Brazilian professionals who are being trained.

The study is organised as follows: related works, course structure, extracurricular activities, professors, students, and intellectual production. Sections have been selected to cover all areas of the program and to provide insight into the surrounding categories.

2. RELATED WORKS

The works related to the case study herein presented are the ones that address the practice and introduction of M-learning applied in a context of higher education, at graduate level.

Bauer et al. (2020) state that a range of scenarios of different types of learning can be used in higher education, from individual M-learning units to virtual teaching. In their work, the authors used as example practical and pedagogical scenarios—videos, weblogs, e-portfolios, wikis, online research tools, and collaborative tools—developed and applied by participants of MINE Project in partner universities.

Farley et al. (2015), in *How Do Students Use Their Mobile Devices to Support Teaching? A Case Study from an Australian Regional University*, concluded in their case study at the University of Southern Queensland on the need for pedagogical approaches that are more focused on student's learning and the improvement of their critical thinking, collaboration, and communication. These approaches should encourage students to take responsibility for their own learning so they can apply theoretical concepts in real situations.

In Bangladesh, Biswas et al. (2020) shared a questionnaire by Google Docs, randomly distributed amongst several undergraduate and graduate students in universities in the region, about the perception of the use of M-learning during the beginning of the COVID-19 pandemic. The students were already familiar with M-learning, so the responses were quite positive. Amidst their findings, the authors concluded that mobile learning proved to be a useful tool during that first year of the pandemic, given that the place of study was limited to an environment outside the universities' grounds. In addition, the students also noticed an improvement in the relationship between them and the teachers.

3. COURSE STRUCTURE

The PPEE's mission is to promote personnel training and research on advanced professional practice that helps to evolve scientific and technological knowledge, allowing to train a professional capable of working in technical-scientific and innovative activities. With the inclination to work in any of the professional fields of electrical engineering, without coverage of its sister academic program, the Graduate Program in Electrical Engineering (PPGEE), the focus on cybersecurity makes it possible to meet the needs of the labour market.

In the Federal District of Brazil, it is possible to find a variety of institutions in which the training of professionals and applied research are of great interest. Therefore, the focus on cybersecurity is maintained as the only major area of concentration, despite being broken down into six strongly linked and complementary

lines of research, namely: Information System and Networks Security; Science and Data Engineering; Security and Cyber Intelligence; Decision-making in security and cyber intelligence, processes, data engineering and artificial intelligence; Conceptions and developments of strategic and critical materials; and Security of information processing and Communications in electro-electronic-computer systems.

This structure has been attracting students from institutions or public agencies, generating technology transfer processes and knowledge.

As an assistance to the student's intellectual production, the Central Library of the UnB (BCE) has a collection of 563,069 volumes and 7,902 journal titles, of which 37,145 of the volumes and 2,143 of the journal titles address areas of exact sciences and engineering. On top of being connected to the world wide web, the BCE has a cataloguing and indexing system available for online consultations. The library offers an institutional repository, the Institutional Repository of the UnB (RIUnB), for the dissemination of scientific production carried out at the university. The library also has a Digital Library of Monographs, where an archive of theses, dissertations and monographs produced at the UnB can be found, including those that have been produced at the PPEE.

The update and access to the reference repositories, such as those in the BCE, are extremely important for the foundation of scientific knowledge, and the production of future academic works, as well as for consultations by companies.

It is noteworthy the number of laboratories of the Department of Electrical Engineering, along with classrooms, study rooms, professor's rooms, and administrative areas, with local wireless and affiliated computer networks included available. In three different points of presence of this network, there are routers with 1Gbps connection to the UnB Network (RedUnB), and from this network—via the Metropolitana GigaCandanga Network, with 10Gbps of connection—it is created the National Teaching and Research Network (RNO). Through this network, and using approximately one hundred computers and internet access booths, the student has access to scientific and technical information available through retrieval systems, both in the department itself and in the Dissertations and Theses Base of the Central Library of the UnB and on the Coordination of Superior Level Staff Improvement (CAPES) journal portal.

Although students are currently not using floor spaces of the university—since the use of the personal equipment allows, with the help of mobile networks, easy access from different locations—all classrooms are equipped with computers and multimedia equipment with internet access via wired and wireless network.

For this purpose, the environments of Microsoft Teams and Moodle (Aprender2) from UnB are used with the support of the Centre of Distance Learning (CEAD/UnB) along with Moodle from the Laboratory of Networks (LabRedes)—www.campusvirtual.unb.br. The laboratories remained fully functional during the pandemic of COVID-19 to provide support to professors and technical and administrative staff as well as to students—who are working from home.

The virtual laboratories for the students, important for the development of knowledge about communication networks, were carried out remotely during the pandemic. The students, under guidance, set up their own virtual laboratories, which provided them with greater computational processing capacity; conversely, the laboratories development relied on resources of commercial or personal devices, which, according to the students, led to numerous difficulties associated with hardware, software, capacity, compatibility, amongst others. The students themselves came up with a solution and suggested the assembly of the laboratories by the professors, making them available through VPN, speeding up the process.

The Decision-Making Technologies Laboratory (LATITUDE), where the physical structure of the PPEE is located, has resources from the Law of Information Technology ("Lei da Informática") of the Ministry of Science, Technology, and Innovation (MCTI) through the FUB-Dell contract—signed by the University of Brasília Foundation (FUB) and Dell Computadores do Brasil LDTA. The laboratory is an environment for cooperation between projects, such as: Audit System Project (SIGA), Budget Secretariat (SOF) Project, Integrated Planning and Budgeting System (SIAP) Project, Virtual School of SOF, National School of Public Administration (Enap) Project, Service Management System (SGS), amongst others. This interaction with government agencies, researchers and subjects is important and goes beyond the admission of students to the PPEE for they are able to interact and learn with senior members of various subjects.

The PPEE regulation has been adapted to meet the demands of academia and labour market, for example, currently, there are two mandatory disciplines, namely: Scientific Research Methodology, and Cybersecurity. These disciplines recycle, both in the production of academic works, and in the basic knowledge of the area of interest. The concern lies within the professionals who, numerous times, were estranged from their studies, and needed to become accustomed to the professional master's degree.

The other disciplines are adapted to the specificities and areas of knowledge of the professors, e.g., study of the Law of Guidelines and Bases ("Lei das Diretrizes e Bases"), Data Science, Cryptography, Application of Distributed Networks, and more.

4. EXTRACURRICULAR ACTIVITIES

The program has been helping in the training of professionals, specifically in the forensic sciences field, thus providing higher integration between academia and the productive sector. To that end, together with the Decision-Making Laboratory (LATITUDE), the PPEE connects institutions and government agencies through research projects in which students and professors exchange expertise in order to deliver a quality product.

It is possible to grant paid scholarships to the students participating in projects in partnerships with institutions such as the Brazilian Intelligence Agency (ABIN), the Ministry of Justice and Public Security (MJSP), the National School of Public Administration (Enap), and the Attorney General's Office (AGU). Those students tend to continue the course and have a better performance in other activities.

5. PROFESSORS

The faculty is composed mostly of PhD professors from the permanent personnel of UnB in effective exercise at the university. In general, these professors work in specific orientations and co-orientations, and also teach disciplines.

Intending to explore the synergy created between the university and the productive, and governmental sectors—the target of training and research products—the faculty addresses the professional demand and maintains the adequate adaptation to the program's proposal, allowing to achieve results with a high level of innovation and considerable applicability in the routine of the partner organisations. For this, new criteria of accreditation and tenure of professors were defined in accordance with the objective of obtaining a better evaluation by CAPES. As a result, the program has some of the professors as productivity fellows of the National Council for Scientific and Technological Development (CNPq), and several external participants and visitors who are highly qualified in the Cybersecurity field.

6. STUDENTS

The PPEE offers a professional master's degree, which is one of the few existing in the Midwest ("região Centro-Oeste"), cooperating with economic and social advancement of the region. In particular, the area of concentration of cybersecurity contributes greatly to the development of tools and innovations that boost Public Security and are also used to tackle new types of crime throughout the country as well as to support critical infrastructures of electricity, telecommunications, and internet.

These characteristics make the PPEE a highly sought-after program in its selection process and the candidates opening slots are always taken by the best ranked and approved candidates. Corroborating with this information, the PPEE has students working effectively in several relevant units in the field, with researchers with exclusive dedication in the production of academic content, clearly demonstrating the contribution of the program in these sectors.

Figure 1. Place of professional activity of the students. The figure exhibits a graph with the number of students with exclusive dedication placed in various units with due relevance to the program.
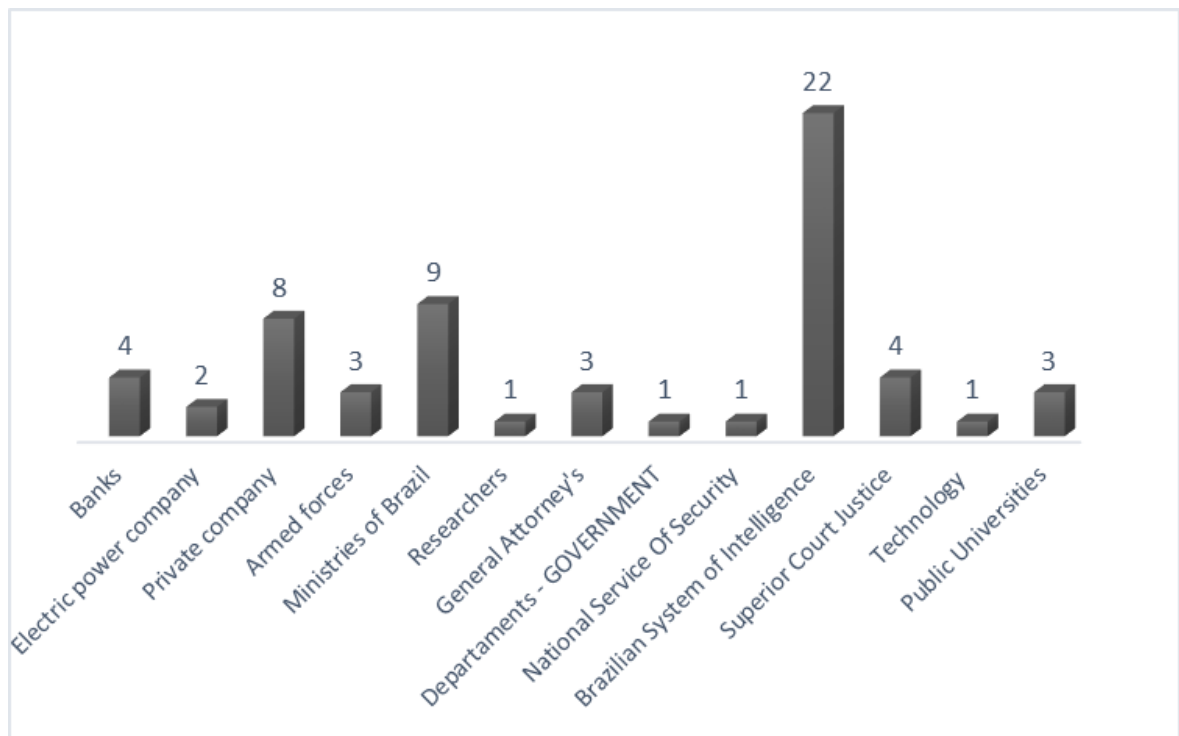
Figure 1. Place of professional activity of the students

7. RESULTS

We conducted a survey questionnaire amongst PPEE teachers and students about the teaching methods the PPEE had adopted during the COVID-19 pandemic, and we received 45 responses, 73.3% students and 26.7% professors. From the analysis of the answers, we gathered that 78.8% of the student respondents agreed that remote learning, synchronous and asynchronous, was appropriate enough to teach about cybersecurity, having the same percentage in terms of achieving the course objective. Amongst the open answers, we noted that students requested more synchronous activities, for longer periods, removing or increasing the deadline for activities outside of class hours.

Aiming to give visibility to the program, the PPEE developed and has been keeping its website updated (https://ppee.unb.br/) in order to disseminate the most significant information. The webpage also provides access to the previously produced master's essays in the program.

At present, the PPEE has almost 800 productions by professors that may have participation of students, as well as a total of 30 essays already defended. It is worth mentioning that due to the COVID-19 pandemic, the classes had a considerable loss in the completion of the course, therefore, with the gradual return of the activities, the students have been organising to defend their essays in the coming months.

Through the Sucupira Platform, from the Coordination for the Improvement of Higher Education Personnel, it is possible to issue an academic production report for the years 2018, 2019 and 2020. Thereby it is clear that most of the works produced are levels A1 and A3, considered the best pointers.

Figure 2. Academic productions. The figure presents a graphic demonstrating the number academic productions referring to the years 2018, 2019, and 2020 in relation to the level of the papers.
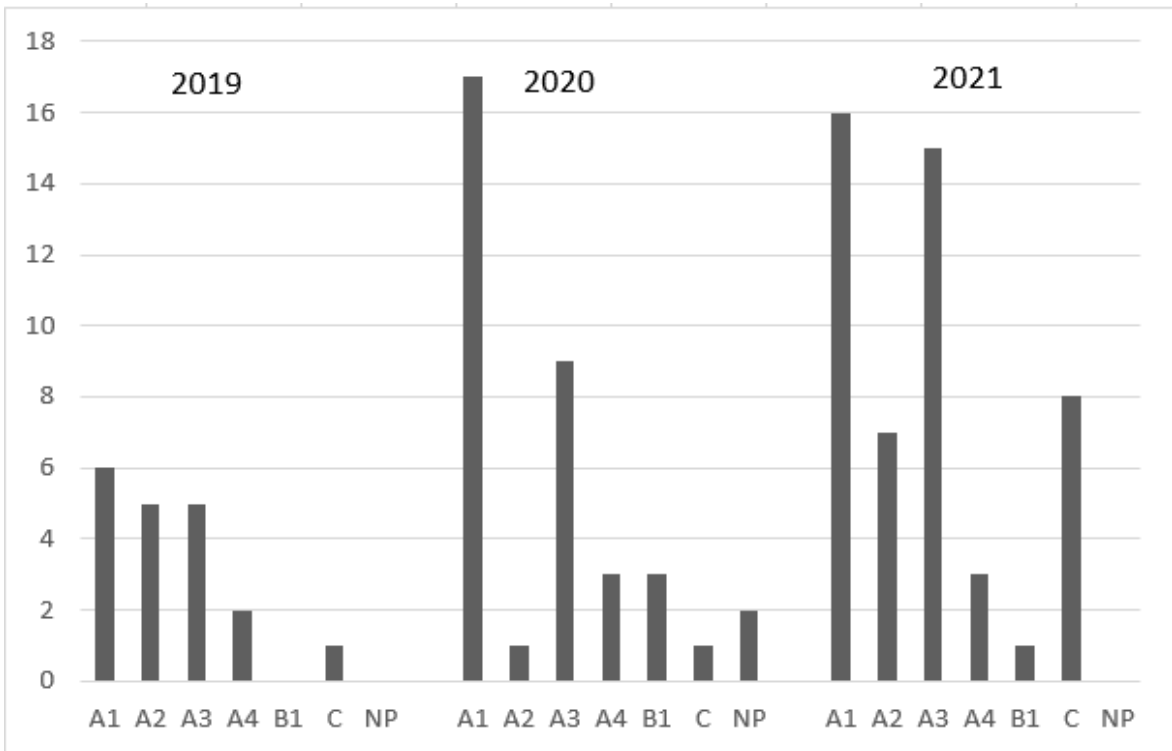
Figure 2. Academic productions

According to the Qualis Journals Report by the Coordination for the Improvement of Higher Education Personnel (2019), "Non-scientific journal" (NPC) means "vehicles that do not meet the definition of a scientific journal"; "C" refers to journals that do not meet the criteria of strata "A1" to "B4"; strata "A1", "A2", "A3", "A4", "B1", "B2", "B3", and "B4" are evaluated by strictly observing the percentage limits of journal distribution established by the Technical and Scientific Council of Higher Education (CTC – ES), with "A1" having the highest stratum (75%) and "B4" the lowest (40%).

The program supports, and has professors who participated in the organisation of technological and scientific events, such as the Simpósio Brasileiro de Segurança da Informação e de Sistemas Computacionais ("Brazilian Symposium on Information Security and Computer Systems") – SBSeg 2020 (Coordination of the Computational Forensics Workshop – WFC); SBrT 2020 (Financial Coordination); WCNPS 2020 – 5th Workshop on Communication Networks and Power Systems (General Chair, TP Chair, Local Organisation and Reviewers); Conferência Integrada ("Integrated Conference") ICCYBER and ICoFCS (partners and collaborators are organisers and committee members); CIARP 2021 (not held in 2020 due to COVID-19) and; o InterForensics 2021 (not held in 2020 due to COVID-19)—recognised as the largest integrated Forensic Sciences event in Latin America, amongst other forums in the region.

8. CONCLUSION

It is notable that information technology has grown in recent years, being linked to cybersecurity to solve current and future problems, and we can observe its impact in today's society with the use of technological resources.

As it is a relatively new program, we noted that the Graduate Program (PPG) achieved good stability in the structuring of its objectives, in the faculty and students, and, mainly, it has reached a high level of published academic productions.

Studies indicate that the PPEE has been helping in the training of qualified professionals in the cybersecurity field, and that the work developed, both by professors and students, are up-to-date and have contributions to the reality of the labour market.

We must pay attention to the research on related courses and contemporary demands post-pandemic. The current study shows the necessity to advance in the understanding of teaching techniques to professionals in the cybersecurity field.

Therefore, we intend in future studies to go deeper into education in cybersecurity, which is beneficial to our society as a whole.

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REFERENCES

Al-Emran, M., Mezhuyev, V., & Kamaludin, A. (2018). Technology acceptance model in M-learning context: A systematic review. *Computers & Education, 125*, 389-412. https://doi.org/10.1016/j.compedu.2018.06.008

Al-Emran, M., Mezhuyev, V., & Kamaludin, A. (2020). Towards a conceptual model for examining the impact of knowledge management factors on mobile learning acceptance. *Technology in Society, 61*, 101247. https://doi.org/10.1016/j.techsoc.2020.101247

Bauer, P. B., Kolb, C., & Bastian, J. (2020). *16th International Conference Mobile Learning 2020*. IADIS Publications. https://www.iadisportal.org/components/com_booklibrary/ebooks/202004C012.pdf

Biswas, B., Roy, S. K., & Roy, F. (2020). Students Perception of Mobile Learning during COVID-19 in Bangladesh: University Student Perspective. *Aquademia, 4*(2), ep20023. https://doi.org/10.29333/aquademia/8443

Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Brasil). *Relatório do Qualis Periódicos: Área 26 Direito.* In: Relatório do Qualis Periódicos: Área 26 Direito. 26.dire@capes.gov.br: Diretoria de Avaliação, 2019. Disponível em: https://www.gov.br/capes/pt-br/centrais-de-conteudo/relatorio-qualis-direito-pdf. Acesso em: 12 dez. 2023.

Corbeil, J. R., & Valdes-Corbeil, M. E. (2007). Are you ready for mobile learning? *Educause Quarterly, 30*(2), 51-58. https://www.learntechlib.org/p/101389/

Farley, H., Murphy, A., Johnson, C., Carter, B., Lane, M., Midgley, W., … Koronios, A. (2015). How Do Students Use Their Mobile Devices to Support Learning? A Case Study from an Australian Regional University. *Journal of Interactive Media in Education*, *2015*(1), Art. 14. DOI: http://doi.org/10.5334/jime.ar

Maia, M. C., & Meirelles, F. (2009). *Tecnologia de Informação e Comunicação aplicada à Educação* [Information and Communication Technology applied to Education]. ACORN-Redecom (Américas Communication Research Network - Red Americana De Investigación e Información y Comunicación. https://www.academia.edu/28327579/Tecnologia_de_Informa%C3%A7%C3%A3o_e_Comunica%C3%A7%C3%A3o_aplicada_%C3%A0_Educa%C3%A7%C3%A3o

Measuring digital development: facts and figures 2021. (2021). International Telecommunication Union (ITU). https://www.itu.int/en/ITU-D/Statistics/Documents/facts/FactsFigures2021.pdf

Programa de Pós-Graduação Profissional em Engenharia Elétrica [Professional Graduate Program in Electrical Engineering]. (n.d). Universidade de Brasília (UnB). https://ppee.unb.br/?page_id=32

Redação. (2022, April 11). *Brasil foi o 5º país com mais ataques cibernéticos em 2021* [Brazil was the 5th country with the most cyberattacks in 2021]. Security Report. https://www.securityreport.com.br/overview/brasil-foi-o-5o-pais-com-mais-ataques-ciberneticos-em-2021/#.Y4u0ZHbMJPZ

Universidade de Brasília. (2020). *Resolução do Conselho de Ensino, Pesquisa e Extensão nº 0117/2020* [Resolution of the Teaching, Research and Extension Council no 0117/2020]. http://medicinatropical.unb.br/images/Normas/CEPE_117_2020_Planejamentodo_2-2020.pdf

Universidade de Brasília. (2020). *Resolução do Conselho de Ensino, Pesquisa e Extensão nº 0098/2020* [Resolution of the Teaching, Research and Extension Council no 0098/2020]. http://dpg.unb.br/images/Resoluo_CEPE_0098-2020_Regulamenta_os_Programas_de_Ps-Graduao_stricto_sensu.pdf

Universidade de Brasília. (2020). *Resolução do Conselho de Ensino, Pesquisa e Extensão nº 0080/2021* [Resolution of the Teaching, Research and Extension Council no 0080/2021]. https://drive.google.com/file/d/1sYD7oqxbDkYjAckpBVxTh4M89W7s3swr/view

Universidade de Brasília. (2020). *Resolução do Conselho de Ensino, Pesquisa e Extensão nº 0217/2016* [Resolution of the Teaching, Research and Extension Council no 0217/2016]. http://dpg.unb.br/images/Legislacao/RegulamentacaoUnB/Resoluo%20217-2016%20SEI_23106.076650_2016_19.pdf

Universidade de Brasília. (2021). *Regulamento do Programa de Pós-Graduação Profissional em Engenharia Elétrica* [Regulation on the Professional Graduate Program in Electrical Engineering]. https://ppee.unb.br/wp-content/uploads/2021/02/2021.02.22-2o-Regulamento-SEI_23106.006579_2021_74.pdf