Adequacy of Information Systems Programs: An Evaluation of Pedagogical Projects and Syllabi in Brazilian Higher Education

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Abstract. *Higher Education Institutions (HEIs) must continuously adapt their curricula to meet market demands. This study examines Information Systems (IS) education in Brazilian HEIs, identifying gaps in program alignment with regulatory and scientific guidelines. An exploratory content analysis was conducted using quantitative and qualitative methods in Syllabi and Pedagogical Projects. The study aimed to identify how interdisciplinarity, competency-based learning, and the graduate profile are being addressed in IS programs. Findings indicate that while HEIs comply with regulations, curricula require updates to integrate competency-based education and interdisciplinary approaches recommended by scientific societies. The study contributes to discussions on IS education in Brazil, offering insights for future research and policy development.*

1. Introduction

The use of Information Systems (IS) is vital for strengthening organizational success and decision-making tools [Hera et al. 2024]. IS professionals can positively impact employees' perception of utility and usability, while also encouraging a deeper exploration of these systems [Karimikia et al. 2020]. However, there is a shortage of technology professionals with the appropriate skills [Forum 2023].

To supply the market with professionals who meet this demand, IS program content must be aligned with various stakeholders (industry, government, and educational institutions), ensuring that pedagogical projects are robust and provide adequate training [Lopes et al. 2017]. Although one of the objectives of IS education is to continuously adapt to the dynamic market of knowledge and skills [Boehler et al. 2020], updating curricula remains a challenge for Higher Education Institutions (HEIs) [Janicki and Cummings 2022].

This study investigates whether IS programs at major Brazilian HEIs align with contemporary market demands and examines the practices they adopt in curriculum development. By analyzing the extent to which these programs integrate competency-based models and interdisciplinary methodologies, the study provides a comprehensive overview of the current state of IS education in Brazil. The findings underscore the need for HEIs to update their curricula, particularly by incorporating competency-based education and interdisciplinary learning strategies. Most of the analyzed HEIs also reference the curriculum guidelines from scientific societies in some capacity but do not fully implement their recommendations.

The article is organized as follows: Section 2 provides the research background; Section 3 reviews related work; Section 4 details the methodology; Section 5 presents the results and discussion; Section 6 addresses study limitations; and Section 7 concludes with final remarks and directions for future research.

2. Background

2.1. Interdisciplinarity

Interdisciplinarity is a pedagogical tool designed to overcome the isolation of individual disciplines within the curriculum. It maintains the connection between disciplines and human activities, reducing the gap between the university and society [Aires 2011]. It enables flexibility and adaptation to complex realities in the creation of disciplines, reaching different students in various contexts and respecting each individual's learning pace [Gesser and Ranghetti 2011]. In addition to curriculum adaptation, it also recovers motivation and engagement among students and creates a link between theory and professional practice [Mesquita et al. 2018].

Although the teacher is often seen as the holder of content, students also enter HEIs with prior knowledge and experiences. Thus, the role of the teacher is to assist in building new knowledge based on that which already exists. Interdisciplinarity benefits this mediation and represents a pedagogical opportunity to provoke, question, and intervene, generating new content [Amboni et al. 2012].

2.2. Competency-Based Learning

One approach to incorporating interdisciplinarity is the use of competency-based learning in curricula. This approach aims for flexible planning and pedagogical choices that facilitate the application of content in real-life situations [Ricardo 2010]. Although theory is a necessary condition for critical action when addressing problem-solving situations [Bersan and Cloux 2020], competency-based learning critiques the overemphasis on content-focused approaches. Competencies represent a new paradigm that involves a shift from a simplified reference framework to one that values the relationship and integration of diverse expertise areas in the production of knowledge [Bersan and Cloux 2020].

In the study by [Van der Klink et al. 2007], the main didactic characteristics of competency-based curricula are outlined, including: (i) emphasis on real-world professional issues; (ii) integration of knowledge acquisition and skills application; (iii) student accountability; (iv) cooperative learning; (v) new assessment methods; and (vi) the use of Information and Communication Technologies. The authors also indicate that the primary challenges in implementing this approach are related to: (i) defining the concept of competency, (ii) establishing a professional profile compatible with the skills demanded by the market, and (iii) ambiguity in applying teaching methodologies [Van der Klink et al. 2007]. It is worth noting that the professional profile, or graduate profile, is a foundational element in building a competency-based curriculum.

2.3. Syllabi and Pedagogical Projects

Defining the content, teaching methodologies, and competencies required to achieve the benefits of an IS program for society is a complex task. These decisions must consider the specific educational needs of each region in Brazil and the characteristics and policies of HEIs

[López Álvarez 2021]. Brazilian HEIs have autonomy in curriculum design as long as they meet the *Diretrizes Curriculares Nacionais* (DCN, or National Curriculum Guidelines) defined by *Ministério da Educação* (MEC, or Ministry of Education), which holds the authority to formulate policies and instruments for supervision, control, and evaluation of the federal and private education system [Neves and Martins 2016]. The DCN indicate a desired graduate profile for IS programs and how HEIs should plan to achieve it.

The two main documents prepared by Brazilian HEIs are the Syllabi and the Pedagogical Project (PP). The first document should include the foundational and technological content from both the Computing and IS fields, selecting the degree of scope and depth according to the graduate's expected profile, competencies, and skills [MEC 2016]. The PP, on the other hand, outlines how HEIs should organize content and activities to develop competencies and skills to meet the graduate profile objectives. Additionally, it should include complementary activities, supervised curricular internships, graduation thesis, and the methods of evaluation and monitoring.

2.4. Curriculum Guidelines for Designing IS Programs

In addition to the MEC's involvement, HEIs can also rely on scientific societies that consolidate content and competencies required by the market into curriculum guidelines. Since 1999, the *Sociedade Brasileira de Computação* (SBC, or Brazilian Computing Society) has provided guidelines for the IS program in Brazil. The *Referenciais de Formação para os Cursos de Bacharelado em Sistemas de Informação* (RF-SI) constitutes a curriculum guideline that shifted from a content-oriented approach to one based on expected competencies for graduates, aligning with the MEC's DCN [Zorzo et al. 2017, Cardoso 2015].

Internationally, the first curriculum model was published in 1972 by the Association of Computing Machinery (ACM). Since the establishment of the Association for Information Systems (AIS) in the 1990s, both associations have collaborated on revisions [Leidig et al. 2020]. The most recent version of the Competency Model for Undergraduate Information Systems Programs is the ACM/AIS IS2020. According to ACM, competency is the ability of students to apply knowledge, skills, and dispositions in task execution [Leidig and Salmela 2022]. As with the RF-SI, the competencies in ACM/AIS IS2020 are non-prescriptive and aim to assist HEIs in curriculum planning.

3. Related Work

In Brazil, a pioneering analysis of IS curricula was conducted by [de Albuquerque et al. 2014] ten years ago. This study focused on the structure of 50 programs in Brazilian HEIs, identifying whether they met the requirements of scientific societies and the job market. The courses were classified according to the disciplinary cores of two SBC curriculum guidelines: CR99 and CRSI03.

The authors found varying adherence to SBC recommendations, particularly regarding the proportion of credits suggested by CR99 for each disciplinary core. One notable example is the limited emphasis on courses focused on the introduction to IS, such as General Systems Theory and Fundamentals of Information Systems. While the guidelines recommend allocating 25% of credits to this area, the actual distribution among HEIs ranged from 9.3% to 18.6%. The authors argue that this discrepancy affects the consolidation of the program's identity. They also suggest that SBC's

recommendations may be impractical, that Brazilian curriculum structures are inadequate, or that both factors contribute to the issue.

This study seeks to contribute to an update on the Brazilian scenario, complementing the research by [de Albuquerque et al. 2014] and presenting points not previously addressed by this and other international studies [Pereira 2006, Janicki and Cummings 2022]. This study aligns with their research by assessing the adherence of HEI documents to scientific societies but does not analyze them from the perspective of course content.

A second related study investigates the adoption of the competency model in Brazilian PP, specifically in Bachelor of Computer Science (BCC) programs [Ferreira et al. 2024]. The authors analyzed 20 PP, assessing the presence of graduate profiles, criteria for competency mapping, and strategies for their development. The results indicated a lack of uniformity in the adoption of both Brazilian and international curriculum guidelines, with most HEIs failing to implement the competency model. Additionally, many institutions struggled to define effective strategies for mapping and integrating competencies into their curricula.

Similar to the study by [Ferreira et al. 2024], this research aims to analyze two key aspects for aligning programs with market needs: the graduate profile and the adoption of the competency-based approach, but within the IS context. A third and different aspect examined is the implementation of interdisciplinarity and the elements recommended by MEC.

4. Research Method

The hypotheses formulated for the study assume that the programs focus on competency-based learning, they follow scientific societies' curriculum guidelines, and adhere to MEC guidelines. The empirical method adopted to validate these hypotheses was Bardin's content analysis [Bardin 1977]. The analysis was conducted with the support of ATLAS.ti, a qualitative data analysis software. We created tags to classify the parts of the documents that were related to the researched topic. Segments were classified analytically and exhaustively. For example, interdisciplinarity was assessed by identifying occurrences of the term and its variations. When found, the context was examined to verify whether it indicated implementation measures. The interpretation of the results, corresponding inferences, and hypothesis validation are discussed in the next section.

The MEC portal was used to identify all registered and active IS programs. At the time of the research, 647 IS programs were identified across the country. To establish a population sample, selection was based on two criteria. The first criterion was that programs should be offered in-person, due to the challenge of tracking distance learning students. Thus, 83 distance education programs were excluded, leaving 564 in-person programs across 430 HEIs. The second criterion was that HEIs appear in at least one of three higher education quality rankings: THE[1], RUF[2], and CWUR[3]. The selection criteria for these rankings were the credibility of the first, the national evaluation aspect of the second, and the analysis methodology of the third.

[1]The Times Higher Education World University Rankings 2023 – https://www.timeshighereducation.com/world-university-rankings

[2]Ranking de Universidades da Folha 2019 – https://ruf.folha.uol.com.br/2019/ranking-de-universidades/principal/

[3]The Center for World University Rankings 2023 – https://cwur.org/

Of the 430 HEIs with in-person IS programs, only 72 are listed in at least one of the rankings. The institutional portals of these HEIs were accessed to collect two types of documents: Syllabi and PP. We chose them for their complementary nature and for providing the necessary information for understanding IS programs. E-mail contact was also made for cases where the documents were unavailable or incomplete on the portals. In 25 cases, we did not receive a response or the access to the documents was denied. Consequently, due to the unavailability of certain documents, the sample was reduced to 47 HEIs. The difficulty in accessing these types of documents is a common issue across different countries [Janicki and Cummings 2022, Pereira 2006] and programs [Ferreira et al. 2024].

All Syllabi were identified by letter "S" and a number of identification (S+ID). The same occurred with the PP, that received "PP" + ID. For HEIs with more than one IS program, we added a number to the code to indicate the program version. This is the case, for example, with HEI number 4, which has two programs on different campuses (Documents analyzed from HEI 4: S4-1, S4-2, PP4-1, and PP4-2). A total of 57 Syllabi and PP were analyzed coming from the 47 HEIs. The list of all HEIs analyzed with their respective IDs, the tags used in the analyses, and the results of these analyses can be found in the database provided[4].

5. Results and Discussion

5.1. Year of Pedagogical Projects

Figure 1 presents the creation years of the programs and the most recent PP available from HEI portals or obtained via email[5]. Most programs emerged in the 2000s due to a Brazilian government project (Reuni), which aimed to expand higher education access. In the last decade, only six new programs were created.

The distribution of PP updates is more balanced over time. However, 14 documents date back to 2012, when MEC established PP guidelines, suggesting possible misalignment with current standards. Another nine predate the 2017 update of the SBC curriculum guidelines (RF-SI), potentially impacting competency-based learning approach in the curricula and content selection.

Regarding the IS2020 curriculum update by ACM and AIS, 35 PP could not incorporate its recommendations. The fact that most PP predate 2020 highlights the challenges HEIs face in keeping pace with market demands [Oguz and Oguz 2019]. Additionally, some HEIs may have updated their PP but have not made them publicly available.

5.2. Interdisciplinarity

Of the 57 Syllabi analyzed, 23 explicitly include methods for implementing interdisciplinarity. Among the PP, 50 address this theme [6]. This topic is widely addressed in PP because the MEC requires that the means of implementing interdisciplinarity be specified in this document. However, the lack of explicit methods in 34 Syllabi suggests that most institutions struggle to integrate interdisciplinarity into their curricula or still follow a traditional approach.

[4]Dataset: `https://anonymous.4open.science/r/qualitative_dataset-8571/`

[5]Syllabi generally do not include a date; therefore, we only considered the dates of the PP.

[6]Among the PP that do not include this element, six were established before 2011, and only one was created more recently, in 2021. The *Parecer* CNE/CES nº 136/2012 mandates that PP specify how interdisciplinarity will be implemented [MEC 2012].

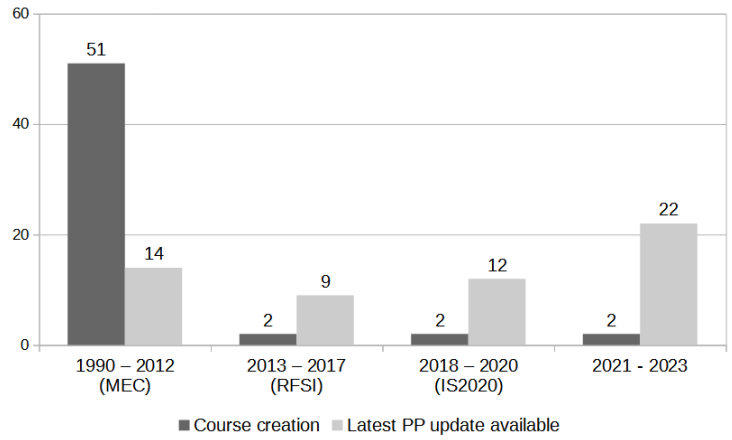

Figure 1. Year of program establishment and updated PPs

The main method of implementation, both in the Syllabi and in the PP, is the Integrative Project (in about 18 Syllabi and 16 PP). A key advantage of this approach is the opportunity to conduct practical work across various courses throughout the semesters [Gonçalves and Pimenta 2004]. The use of interdisciplinary projects also provides meaningful experiences, making the teaching process more dynamic for both students and professors [Mesquita et al. 2018].

Some Syllabi address interdisciplinarity within specific courses. For instance, S26-2 achieves this through two mandatory Interdisciplinary Seminar courses, which explore current topics in Computing, build connections between the program's subjects, introduce the professional environment, and motivate students by showcasing various educational possibilities. Similarly, S34 suggests that students in the General Systems Theory course conduct research on topics related to the Information and Communication Technologies (ICT) field, focusing on the reality of IS in the market and highlighting a commercial product. In other cases, interdisciplinarity is integrated into courses not explicitly designed for this purpose. Problem Solving I (from S01-1), for example, introduces students to interdisciplinary research activities. Another approach involves extension activities that promote interdisciplinary programs or projects through outreach contexts such as workshops, events, and community services (S45-1).

PP proposals suggest complementary activities, special studies courses (emphasis programs), cultural courses, multidisciplinary problem-solving courses, thematic discussions, group projects, events, academic research, extension activities, seminars, and final projects.

5.3. Competency-Based Approach

Of the 47 HEIs analyzed, 34% presented a curricula organized around competencies, with three of them also offering programs using a content-based approach. Although competency-based learning emerged in the 1990s [Deluiz 2001] and has been adopted by the SBC since 2017, most HEIs have yet to fully transition from the traditional content-based model. Approximately 66% (31 HEIs) still adhere to this approach.

Of the 17 Syllabi structured by competencies, 12 have been developed within the past five years. Syllabi S27, S36, S37, S38, and S43 stand out for their flexibility and differentiated structure

compared to other competency-based Syllabi. Instead of traditional academic terms, these Syllabi adopt a structure based on "Core Curriculum", "Area", "Professional", and "Specialization", allowing students to distribute courses according to their needs and learning pace.

Syllabi that follow traditional segmentation typically do so by dividing courses into "Basic Training", "Technological Training", "Humanistic Training", and "Supplementary Training", or similar categories. Among them, S04-2 stands out for its more specific divisions, including "Operating Systems and Computer Networks", "Information Systems", and "Software Engineering".

Although few Syllabi are designed using a competency-based approach, most PP reference competencies and related terms. Considering the desired graduate profile, PP must demonstrate how the set of planned activities will develop the expected competencies and skills [MEC 2012]. They must also detail the curricular organization and its relationship with other components. These documents, however, often lack details on implementing this approach, and only a few explicitly list the competencies.

Nonetheless, we found promising initiatives during the analyses. For instance, PP16 mentions conducting a self-assessment with graduates regarding the competencies and skills developed throughout the program, with opportunities for feedback on program improvement and alignment with professional realities. PP38 outlines ways to foster competency acquisition through interdisciplinarity, promoting student autonomy, using active learning methods, and respecting individual characteristics, among other aspects. Only eight PP do not address competencies at all.

Table 1 presents the division of HEIs in terms of the approach found in Syllabi and whether the PP explicitly mentions the competencies students are expected to develop or not[7]. To analyze whether the IS programs at leading Brazilian HEIs do not employ a competency-based learning approach (H_0), or if they do (H_1), we applied a one-sided binomial test (Table 2). Thus, the statistical test reveals two opposing situations: the null hypothesis is not rejected when based on Syllabi but is rejected when PP are considered. This discrepancy highlights the difficulty in transferring competencies from PP into Syllabi. Nevertheless, the challenge of developing a competency-based curriculum could be easily addressed, given that competencies for the SI graduate profile are described and exemplified in the MEC's DCN and the curriculum guidelines.

Table 1. HEIs Perspectives on Competency and Content-Based Approaches

Syllabi Approach	Does PP Mentions Competencies?	HEIs
Competencies	Yes	12
Competencies	No	1
Competencies and Content	Yes	3
Content	Yes	24
Content	No	6
Content	Yes and No[8]	1

5.4. Graduate Profile

MEC establishes and suggests seven statements that exemplify expectations for the IS graduate profile. Despite this, the institution encourages HEIs to develop customized profiles and competen-

[7]The full list of HEIs with IDs can be seen in the dataset provided.

[8]This HEI offers two programs: one of them includes competencies in its PP, while the other does not.

Table 2. Binomial Test Results

Hyp.	Item	Sample	*N*	p-value	Result
H_0 / H_1	HEI's Syllabi	47	16	0.9936	not rejected
	HEI's PP	47	41	0.0000	rejected

cies. In addition to presenting different programs and specialized profiles, HEIs can establish their own competencies, content, and strategies for implementing the didactic-pedagogical project. To achieve this, it is essential that institutions consider the regional context, program objectives, faculty competencies, and other factors specific to each HEI [López Álvarez 2021, Zorzo et al. 2017].

We analyzed 57 PP and categorized them according to some criteria. The first refers to completeness of the text, i.e., whether or not the PP included all seven points of the MEC's profile. The second classification is based on the writing style, identifying whether the statements are identical to those of the MEC or if the HEI used an authentic wording. Finally, we examined whether the presented profile expanding the graduate profile section, including any additional content.

Figure 2 presents the Venn diagram with the PP that fit into each classification. Only three of the 57 analyzed PP do not specify a graduate profile (in gray). Among the analyzed PP, 34 include all the seven points defined by the MEC (yellow), while 20 cover only some of them (pink). Additionally, 20 reproduce the original text identically (orange), whereas 34 use their own wording (green). The majority (46 PP in blue) also include additional points beyond those specified by the MEC.

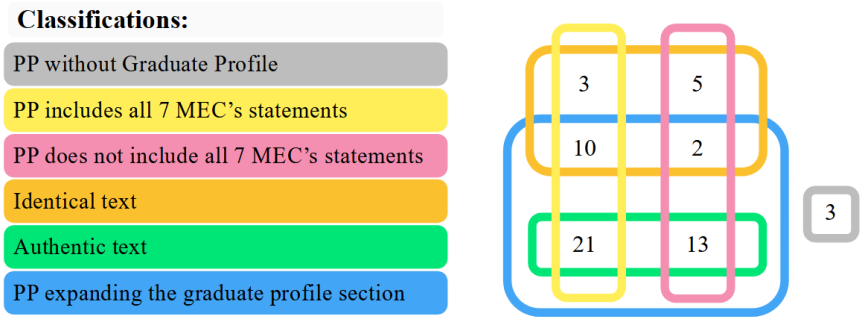

Figure 2. Classification of PP according to the presentation of the Graduate Profile

5.5. Alignment of PP with Scientific Societies and Mandatory Elements Required by MEC

Two sets of hypotheses were formulated to analyze the factors influencing curriculum design: a) adherence to scientific societies and their curriculum guidelines; and b) the inclusion of the 11 mandatory elements recommended by MEC. For the analysis, the following were considered: H_{x0}: $p = 0.5$ and H_{x1}: $p > 0.5$, where x corresponds to the hypothesis set (a or b), and p the proportion of PP with the desired characteristic. Table 3 presents the results of the one-sided binomial test applied to these cases.

In the first set (a), the goal was to examine whether most PP of IS programs at leading Brazilian HEIs fail to include the curriculum guidelines of scientific societies (H_{a0}) or incorporate them (H_{a1}). Only the hypothesis related to the SBC was rejected, as most PP do mention the

society. It was anticipated that this reference would be more prevalent due to its national relevance; however, not all HEIs specified which SBC guidelines they were adhering to. A probable reason for the low adoption to RF-SI and IS2020 might be that the PP were established before these guidelines were introduced. Among the analyzed documents, 13 PP do not reference any scientific society or guideline. In contrast, 44 mention SBC (though not necessarily the 2017 guideline), and 23 cite ACM or AIS. Only two PP follow IS2020, detailing the elective course system and organizing courses into ten concentration areas.

HEIs, faculty members, and the areas involved must exercise their creative and innovative potential in developing the PP, based on 11 essential elements: (I) Program Conception, Justification, and Objectives (general and specific); (II) Offer and Focus; (III) Interdisciplinarity (discussed in Section 5.2); (IV) Integration of Theory and Practice; (V) Assessment and Monitoring; (VI) Integration of Undergraduate and Graduate Studies (if applicable); (VII) Research; (VIII) Outreach Activities; (IX) Graduation Project (if applicable); (X) Supervised Internship (if applicable); and (XI) Complementary Activities [MEC 2012].

The second set (b) analyzes whether most PP of IS programs at leading Brazilian HEIs do not include the mandatory elements determined by MEC (H_{b0}), or if they do (H_{b1}). Except for item VI, which is present in less than 44% of the documents, all null hypotheses were rejected. Overall, HEIs appear concerned with meeting regulatory requirements, yet few HEIs managed to demonstrate ways of integrating undergraduate and graduate programs. Item III was previously discussed, highlighting that although most PP include this topic, it is not necessarily reflected in the Syllabi. Table 3 shows that the remaining elements are usually mentioned in most PP, but it is important to note that no single element appears in all PP.

Table 3. Binomial Test Results

Hyp.	Item	Sample	*N*	p-value	Result
H_{a0} / H_{a1}	RF-SI 2017	57	15	1.0000	not rejected
	IS2020	57	2	1.0000	not rejected
	SBC	57	44	0.0000	rejected
	ACM/AIS	57	23	0.9594	not rejected
H_{b0} / H_{b1}	I	57	55	0.0000	rejected
	II	57	51	0.0000	rejected
	III	57	50	0.0000	rejected
	IV	57	43	0.0001	rejected
	V	57	53	0.0000	rejected
	VI	57	25	0.8871	not rejected
	VII	57	44	0.0000	rejected
	VIII	57	56	0.0000	rejected
	IX	57	48	0.0000	rejected
	X	57	53	0.0000	rejected
	XI	57	55	0.0000	rejected

The reduced mention of undergraduate-graduate integration may result from the lack of graduate programs at the analyzed HEIs. Brazil has 89 computing graduate programs, concentrated in the Southeast (36%) and Northeast (28.1%). Enhancing integration in PP requires expanding and decentralizing these programs across other regions. Even for HEIs that offer graduate

programs, alignment remains a challenge. [Gomes 2012] suggests some actions to improve this integration, such as: increasing the alignment between the curricula of both education levels; enhancing communication between program councils; expanding the availability of undergraduate research scholarships and democratizing access to them; and investing in the physical and technological infrastructure of research centers.

6. Limitations

The main limitation of this study is the sample size, covering only 10.1% of IS programs nationwide. However, it remains representative, encompassing all Brazilian regions and including top-ranked HEIs. Limited access to key documents reduced the sample, impacting the generalizability of findings. Another potential limitation is interpretative bias in qualitative analysis. To mitigate this, one researcher analyzed each document type, with a second reviewing the data. Discrepancies were resolved through joint analysis until consensus was reached.

7. Conclusions and Future Work

The main contribution of this study is providing a comprehensive overview of the current state of IS education in Brazil, identifying both strengths and areas for improvement. This study highlights that most Brazilian IS programs continue to follow a content-based teaching model, with competencies primarily addressed through the graduate profiles outlined in PP. Although the analyzed curricula generally comply with MEC guidelines and reference the SBC recommendations, many PP remain outdated, limiting their ability to fully meet contemporary labor market demands.

As observed in the study conducted by [Ferreira et al. 2024], PP that adhere to the most recent guidelines tend to adopt a competency-based approach. The findings emphasize the need for HEIs to update their curricula, particularly by incorporating competency-based models and interdisciplinary methodologies. Most of the analyzed PP reference SBC in some capacity but do not fully implement its recommendations, aligning with the conclusions of [de Albuquerque et al. 2014].

Some promising practices were identified, such as the inclusion of integrative projects and specific courses. However, these approaches are inconsistently applied across Syllabi and PP. Additionally, the lack of alignment with recent international curriculum guidelines, such as IS2020, highlights gaps in the global competitiveness of Brazilian IS education.

Future research should investigate the implementation of key competency-based curriculum characteristics, as outlined by [Van der Klink et al. 2007], along with the integration of essential soft skills, and the effectiveness of interdisciplinary approaches in fostering student engagement and competence development. Further analysis should include course content scope, infrastructure conditions in HEIs, and the alignment of learning activities with industry demands.

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