HOW TO CLUTCH SKILLS FROM HIGHER EDUCATION CURRICULA: ANALYSIS OF PORTUGUESE LEARNING OUTCOMES

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Abstract

In Portugal, the Agency for Assessment and Accreditation of Higher Education - A3ES - promotes and ensures the quality of higher education, following the development of quality management systems in the European space. Thus, their mission is to contribute to improve the quality of Portuguese higher education, through the assessment and accreditation of Higher Education Institutions (HEI) and their study programmes, and to ensure the integration of Portugal in the European quality assurance system of higher education. This agency performs the assessment and accreditation of higher education study programmes in 1st, 2nd and 3rd cycles. At an initial stage of the accreditation process, HEI submit an accreditation proposal to A3ES. In the description of each study programme for evaluation, HEI must describe what are the "intended learning outcomes" they expect students will achieve at the end of a specific learning period. The information included in this description, which is limited to 1000 characters, was examined to all study programs' proposals submitted for accreditation from 2009 to 2014 ($N = 2961$). A content analysis was carried out using the MAXQDA software for qualitative data analysis. Adopting a theoretical thematic analysis approach, a competence matrix of technical and generic skills was identified. Based on these qualitative results, a set of 30 learning competencies, cited in all the Portuguese study cycle curricula official documentation, was analysed. The relative importance of a given competency, in each curriculum, was roughly estimated by counting the number of corresponding mentions in the document submitted to A3ES for approval. A Principal Component Analysis (PCA), with varimax rotation, allowed the association of the 30 competencies with nine components. Each component was, then, characterized based on the initial variables' loadings. The nine components could also be related with several distinct features of the higher education study programmes (study cycle and scientific area) and institutions (geographical location, university/polytechnic subsystem, and private/public sector). This study aims to contribute to the identification of areas for improvement of study programmes in Portugal.

Keywords: Skills, Higher Education, Curricula, Learning Outcomes, Principal Component Analysis.

1 INTRODUCTION

Higher Education Learning Outcomes (HELO) are a key feature on the development of qualification frameworks and a central part of the Bologna Process. [1] Across most European countries, HELO can be used either as a teaching/learning tool or as a quality indicator of the Higher Education Institutions (HEI), based on which some quality assurance systems rely. [2] In Portugal, the Agency for Assessment and Accreditation of Higher Education (A3ES) partially appraises the reported learning outcomes in the study programs' proposals submitted for accreditation to assess their quality.

Learning outcomes are, thus, used to evaluate study programmes and HEI and intrinsically relate to the acquirement of knowledge, expressing what students should learn in higher education. In fact, learning outcomes should be "verifiable demonstrations" of what students should know or be able to do as a result of a learning process, stressing the constructivist alignment of the learning outcomes with the assessment process. [3]. They are usually written using professional contexts as a source of inspiration, but they can be very different from the world of work competencies' demands. In fact, disciplinary and professional skills are measuring different concepts in different contexts. [4] Therefore, it seems important to find a set of competencies that better conform to both academic and professional worlds, given that educational systems need to continuously adapt to meet the demands of the economy, so that the skills possessed by employees match the skills required by employers.

According to recent trends, there are six drivers (people's longevity, smart machines and systems development, increased computational world, new media and communication tools, highly structured organizations and global connectivity) that will reshape the landscape of work in the next years,

demanding new skills from the future workforce. [5] Many recent studies address this problem, stressing how skills required by the employers are changing. [6-10] The relevance attributed to various skills is reordering, some are dropping, and others are emerging, as exemplified in Table 1.

Table 1. Top 10 skills considered important in the workforce in 2015 and perceived for 2020. [9].

In 2015	In 2020
1. Complex problem solving	1. Complex problem solving
2. Coordinating with others	2. Critical thinking
3. People management	3. Creativity
4. Critical thinking	4. People management
5. Negotiation	5. Coordinating with others
6. Quality control	6. Emotional intelligence
7. Service orientation	7. Judgment and decision making
8. Judgment and decision making	8. Service orientation
9. Active listening	9. Negotiation
10. Creativity	10. Cognitive flexibility

Although with different names, some skills are consistently emerging, such as “sense-making and cognitive load management”, or the ability to determine the deeper meaning or significance of what is being expressed, to discriminate and filter information for importance, and to understand how to maximize cognitive functioning using a variety of tools and techniques, and “emotional or social intelligence”, or the ability to connect to others in a deep and direct way, to sense and stimulate reactions and desired interactions. Other relevant emerging skills, not listed in Table 1, include “computational thinking” (the ability to translate vast amounts of data into abstract concepts, and to understand data-based reasoning) and “new-media literacy” (the ability to critically assess and develop content that uses new media forms, and to leverage these media for persuasive communication). [5]

Addressing the search for a better adjustment between academic and professional skills, and the emergence of forthcoming work skills, this work analyses the Portuguese HELO. The core skills currently offered by HEI are identified, compared and contrasted with key work skills required in the near future. A cross analysis with Portuguese HEI main characteristics aims at achieving a fine-tuning of the offered/required skills, contributing to connect the higher education and professional contexts.

2 METHODOLOGY

Population: A total of 2961 Portuguese study cycle curricula, corresponding to all programs submitted to A3ES for accreditation from 2009 to 2014, was analysed.

Higher Education Learning Outcomes (HELO): Adopting a theoretical thematic analysis approach, instead of a data-driven option, [11] a qualitative content analysis of the study programs, carried out using MAXQDA v.12 software, allowed identifying a competence matrix of technical and generic skills. Based on these qualitative results, a set of 30 main learning outcomes was extracted, whose relative importance in each curriculum was roughly estimated by counting the number mentions in the official document submitted to A3ES for approval.

Study Programmes (SP) and Higher Education Institutions (HEI): Distinct features of the study programmes (study cycle and scientific area) and of the higher education institutions offering them (geographical location, university/polytechnic subsystem and private/public sector) were characterized using IBM SPSS Statistics v.25.

Higher Education Competencies (HEC): A Principal Component Analysis (PCA), with varimax rotation, [12] allowed associating the 30 HELO into nine components. Each component was characterized based on the initial variables’ loadings and used to identify nine major higher education competencies, measuring specific groups of learning outcomes. The relative importance of HEC in each curriculum was then computed by building a new set of variables, considering exclusively the main

contributing learning outcomes in each component. HEC were then ranked in importance using the mean component scores over all curricula, and their relevance was associated with the HEI features analysed. IBM SPSS Statistics v.25 was also used in this analysis.

3 RESULTS

3.1 HELO identification and relevance

The 30 learning outcomes identified and their relevance (mean and standard deviation of the number of mentions) are presented in Table 2.

Table 2. Number of mentions' mean (M) and standard deviation (SD) of the Portuguese HELO.

Learning outcome	*M*	*SD*
LO1 – Critical and reflective thinking	1.60	1.575
LO2 – Specific knowledge	1.30	1.850
LO3 – Practical knowledge	1.28	1.989
LO4 – Information management capability	0.94	1.310
LO5 – Theoretical knowledge	0.68	1.276
LO6 – General knowledge	0.60	0.870
LO7 – Innovation	0.58	1.013
LO8 – Organization and planning capacity	0.55	0.915
LO9 – Problem solving	0.53	0.825
LO10 – Written communication skills	0.51	0.728
LO11 – Oral communication skills	0.47	0.686
LO12 – Information technologies skills	0.47	1.311
LO13 – Autonomous learning skills	0.37	0.595
LO14 – Leadership	0.37	0.813
LO15 – Creativity	0.36	0.715
LO16 – Concern about social, economic and environmental sustainability	0.36	0.755
LO17 – Motivation for lifelong learning	0.34	0.575
LO18 – Team work	0.32	0.543
LO19 – Adaptation to new situations	0.31	0.638
LO20 – Personal and social responsibility	0.29	0.587
LO21 – Ethics and professional deontology	0.27	0.534
LO22 – Initiative and entrepreneurial spirit	0.20	0.479
LO23 – Motivation for excellence	0.20	0.462
LO24 – Decision making	0.20	0.493
LO25 – Research and investigation	0.17	0.646
LO26 – Interpersonal relationship skills	0.13	0.397
LO27 – Interdisciplinary team work	0.10	0.319
LO28 – Respect for diversity and multiculturalism	0.06	0.265
LO29 – Command of a foreign language	0.04	0.238
LO30 – International team work	0.02	0.136

As expected, most of the top six HELO (LO2, LO3, LO5 and LO6) are knowledge related, expressing what academia expects students to achieve by completing a study programme. Grippingly, critical and reflective thinking (LO1) appears first, translating a common demand from academic and professional contexts, and one of the emerging professionally required skills, information management capability (LO4), appears fourth. This clearly reflects how HELO are usually written based in professional contexts but still very disciplinary oriented.

3.2 HEI and SP characterisation

The Portuguese Higher Education landscape can be indirectly characterized based on the number of study programme curricula submitted to A3ES for accreditation. Table 3 shows these figures separated by HEI features (education subsystem, operating sector and geographical location) and type of SP (study cycle).

Table 3. Portuguese Higher Education landscape characterization.

Features		Frequency	Group %
Education Subsystem	University	1981	66.9
	Polytechnic	980	33.1
Operating Sector	Public	2252	76.1
	Private	709	23.9
Geographic Location[(a)]	Littoral	2101	71.8
	Interior	751	25.6
	Islands	76	2.6
Study Cycle	BSc	1040	35.1
	MSc	1500	50.7
	PhD	421	14.2

[(a)]Some study cycles are running as consortium between HEI in different geographical locations and, thus, not attributable any particular region.

Most Portuguese HEI (67%) are universities, most operate in the public sector (76%) and the majority is in the littoral region (72%). Actually (data not shown) 33% of the SP submitted from 2009 to 2014 (979 out of 2961) were from public universities located in the littoral. In what concerns study cycle degrees, roughly half of the submitted SP are masters' degrees (MSc, 51%), 35% are bachelor's degrees (BSc) and only 14% are Doctoral programmes (PhD).

3.3 HEC identification, ranking and characterisation

3.3.1 Principal components analysis of the HELO

In order to identify the underlying competencies that summarize the 30 main learning outcomes, a PCA was performed, followed by an orthogonal rotation (Varimax with Kaiser normalisation) of the component axes to maximize the variance of the squared loadings of each component on all the variables. [13]

A preliminary check indicated that the extent of intercorrelations among the measurement items justified the applicability of PCA (Kaiser-Meyer-Olkin Measure of sampling adequacy index=.779, and significant Bartlett's Test of Sphericity ($\chi^2(435) = 16032.2, p < .001$), allowing to reject the null hypothesis that the correlation matrix is an identity matrix. [12]

Nine components (with eigenvalues >1, following the Kaiser criterion [14]) were extracted, accounting for 53% of the variance of the measures. Component 1 accounted for 15% of the explained variance (eigenvalue: 4.6), component 2 for 7% (eigenvalue: 2.1), components 3 to 5 for 5% each, and components 6 to 9 for 4% each. Extraction results are presented in Table 4 and the scree plot, [15] confirming the number of factors being retained, is depicted in Fig. 1. The rotated component coefficients and communalities of the final nine-component solution for each learning outcome are presented in Table 5.

Table 4. Initial eigenvalues and percent of variance explained of HELO data.

Component	Initial Eigenvalues	% of Variance	Cumulative %
1	4.558	15.193	15.193
2	2.085	6.949	22.141
3	1.621	5.403	27.544
4	1.557	5.190	32.734
5	1.520	5.068	37.802
6	1.269	4.230	42.032
7	1.141	3.803	45.834
8	1.122	3.739	49.574
9	1.062	3.540	53.114

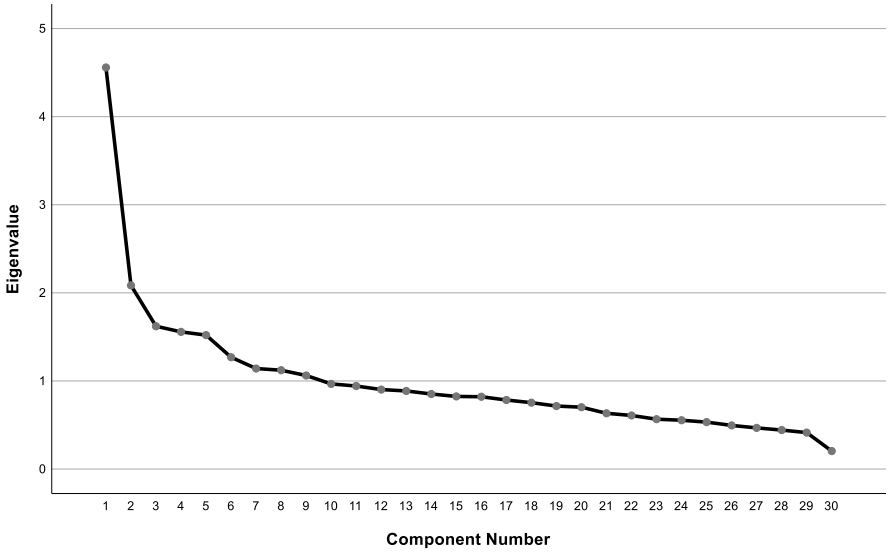

Figure 1. Screeplot of the eigenvalues of the components.

Table 5. Rotated component coefficients, sorted by size, and communalities (h^2) of the final 9-component solution for each HELO.

Learning Outcome	Component									h^2
	1	2	3	4	5	6	7	8	9	
LO9	**0.674**	0.155	0.208	0.003	-0.021	0.027	-0.015	-0.097	0.120	0.547
LO17	**0.636**	0.033	0.128	-0.097	0.097	-0.246	-0.129	0.018	0.017	0.519
LO20	**0.576**	-0.039	0.074	**0.424**	0.094	0.083	0.137	0.082	-0.108	0.571
LO21	**0.561**	-0.033	0.027	0.217	0.090	0.151	0.305	0.149	0.011	0.510
LO19	**0.499**	0.214	-0.006	0.026	0.098	0.082	-0.036	0.044	0.166	0.342
LO6	0.420	0.030	0.059	0.130	-0.017	0.037	-0.088	0.055	-0.325	0.316
LO13	0.399	-0.088	0.383	-0.053	0.262	-0.258	-0.222	-0.053	0.071	0.510
LO24	0.353	0.111	0.083	-0.129	0.173	0.341	0.138	-0.149	0.266	0.419
LO12	0.102	**0.727**	0.060	-0.002	-0.058	-0.118	0.067	0.066	-0.062	0.573
LO14	0.109	**0.667**	-0.071	0.051	0.256	0.019	0.080	0.018	0.041	0.538

LO3	0.085	**0.647**	0.042	-0.025	0.058	0.372	-0.089	-0.026	0.130	0.595
LO7	0.021	**0.588**	0.103	**0.523**	0.001	-0.179	-0.145	-0.035	0.039	0.686
LO8	-0.008	0.374	0.131	0.114	0.354	0.217	0.289	-0.126	0.011	0.442
LO11	0.150	0.003	**0.828**	0.082	0.043	0.044	0.164	0.134	-0.018	0.764
LO10	0.161	0.010	**0.825**	0.035	0.081	0.194	0.095	0.103	0.002	0.771
LO4	0.105	0.227	**0.515**	0.421	-0.062	0.134	-0.147	-0.070	-0.065	0.557
LO16	0.212	0.155	-0.049	**0.648**	-0.064	0.107	0.105	0.025	0.004	0.518
LO23	-0.075	-0.118	0.211	**0.595**	0.146	-0.130	0.076	-0.099	0.068	0.477
LO18	0.169	0.119	0.185	-0.085	**0.670**	-0.042	0.046	-0.037	-0.081	0.545
LO26	0.051	-0.003	-0.009	-0.016	**0.638**	0.207	0.162	0.204	-0.009	0.521
LO22	0.059	0.114	-0.068	0.269	**0.532**	-0.085	-0.157	0.104	0.076	0.425
LO5	-0.092	-0.094	0.113	-0.054	0.001	**0.699**	-0.165	0.116	-0.053	0.564
LO1	0.299	0.243	0.341	0.142	0.141	**0.532**	-0.018	-0.085	0.065	0.599
LO2	0.079	0.316	0.072	0.095	0.037	-0.106	**0.645**	0.077	-0.085	0.562
LO25	-0.118	-0.184	0.148	0.075	0.156	-0.157	**0.604**	-0.110	0.301	0.591
LO15	0.058	0.295	0.054	0.330	0.189	-0.016	**-0.417**	-0.008	0.274	0.487
LO28	0.103	-0.054	-0.025	0.062	0.196	0.036	-0.030	**0.691**	0.013	0.537
LO29	-0.027	0.121	0.266	-0.198	-0.005	0.006	0.035	**0.644**	0.063	0.545
LO27	0.176	0.069	0.005	0.007	-0.002	0.005	-0.017	-0.016	**0.668**	0.482
LO30	-0.061	-0.021	-0.034	0.125	-0.081	0.024	0.009	0.367	**0.506**	0.419

Note: factor loadings with absolute value above 0.4 are highlighted in bold.

3.3.2 Major competencies derived from the PCA analysis

Following the PCA of the 30 HELO, the nine components were associated with nine major skills, or competencies (HEC), that were labelled as:

- Component 1 - *Complex problem solving*, consisting of “problem solving” (LO9), “motivation for lifelong learning” (LO17), “personal and social responsibility” (LO20), “ethics and professional deontology” (LO21), and “adaptation to new situations” (LO19).
- Component 2 - *Technical competencies & leadership*, consisting of “information technologies skills” (LO12), “leadership” (LO14), “practical knowledge” (LO3) and “innovation” (LO7)
- Component 3 - *Communication & new-media literacy*, consisting of “oral communication skills” (LO11), “written communication skills” (LO10) and “information management capability” (LO4).
- Component 4 - *Excellence & sustainability*, consisting of “concern about social, economic and environmental sustainability” (LO16) and “motivation for excellence” (LO23).
- Component 5 - *Social intelligence*, consisting of “team work” (LO18), “interpersonal relationship skills” (LO26) and “initiative and entrepreneurial spirit” (LO22).
- Component 6 - *Critical thinking*, consisting of “theoretical knowledge” (LO5) and “critical and reflective thinking” (LO1)
- Component 7 - *Research & development*, consisting of “specific knowledge” (LO2), “research and investigation” (LO25), and “creativity” (LO15).
- Component 8 - *Cross-culturalism*, consisting of “respect for diversity and multiculturalism” (LO28), and “command of a foreign language” (LO29).
- Component 9 - *Interdisciplinarity & collaboration*, consisting of “interdisciplinary team work” (LO27), and “international team work” (LO30).

The relative importance attributed to these major HEC is shown in Fig. 2. As expected according to “The 10 skills you need to thrive in the Fourth Industrial Revolution” [10], the most valued competency is *Critical thinking* (ranked 2 in this list, see Table 1), or the proficiency at thinking and coming up with

solutions and responses beyond what is rule-based. The following two competencies are not in this skills' list (Table 1) but have also been identified among the top 10 21st century skills [5, 16]: *Technical competencies & leadership* involves the ability to translate massive amounts of data into abstract concepts and to understand data-based reasoning (computational thinking and digital fluency); *Communication & new-media literacy* involves the capacity of using diverse media forms to critically assess and develop content, and to persuasively communicate through them.

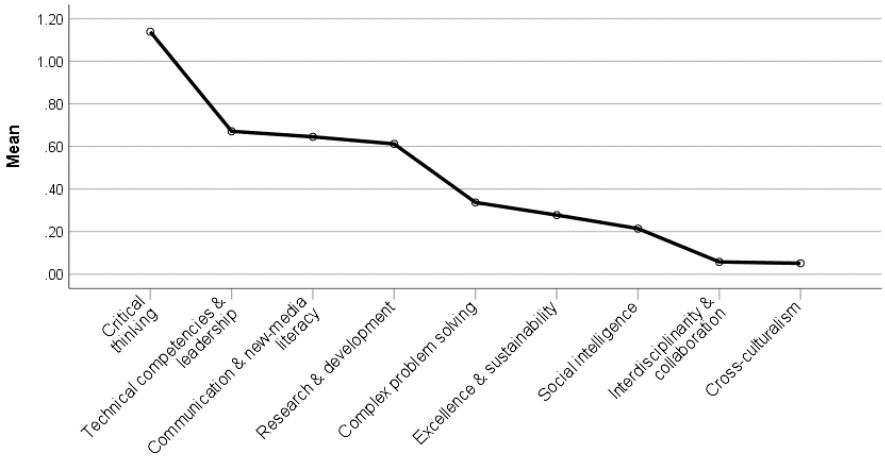

Figure 2. Portuguese HEC ranking based on the estimated mean number of mentions of each major competency in the curricula submitted to A3ES for approval.

Surprisingly, the fourth most relevant competence in Portuguese curricula, *Research & development skills*, is not listed in any of the top 10 work skills, usually appearing as part of other core skills, such as analytical thinking or complex problem solving [8]. The latter involves the ability to retrieve the deeper meaning from available information in order to solve novel, loosely defined problems in complex, real-world settings. It is worth mentioning that *Complex problem solving* appears in 5th in the Portuguese rank, contrasting with most other classifications (complex problem solving, sense making, analytical skills, analysis/solution mindset, and so on) [5, 8-10] where it stands in the top 3 positions. *Excellence & sustainability* comes next and, although not directly mentioned in most ranks, it can be associated with judgment and decision making and service orientation (ranked 7th and 8th in 2020 top 10 skills identified in Table 1 [9]), involving the ability to represent and develop tasks and work processes for desired outcomes. Sustainability orientation is most relevant for small businesses, where it seems to be the motivation for excellence and corporate social mobilization [17]. Thus, it is not surprising that it appears in the Portuguese HEC ranking, given the high number of small businesses in the country. The last three competences in the Portuguese HEC ranking are emerging competences that appear in almost every 21st century ranking with higher or lower expression. *Social intelligence* involves the ability to connect deeply with others and sense how they feel, in order to maintain good social interactions. It is also commonly referred as emotional intelligence, self-awareness, social awareness or social perceptiveness, among others. *Interdisciplinarity & collaboration* is related to both cognitive flexibility (literacy and ability to understand concepts across multiple disciplines and to categorise information to optimise cognitive functioning) and coordinating with others (mostly virtual collaboration, involving the ability to work effectively, drive engagement and establish a virtual presence in a working team). Last, but not least, *Cross-culturalism* involves the ability to operate in different cultural settings and is commonly ranked as cross-cultural competency, diversity awareness, cultural literacy, among others.

3.4 Cross-analysis of HEC by HEI and SP characteristics

Besides the rank analysis made in the previous paragraph, it may be pertinent crossing the relevance attributed to each HEC with the other the HEI (subsystem, operating sector and geographical location) and SP (study cycle and scientific area) characteristics. This graphical analysis is presented in Fig. 3 and Fig. 4.

Concerning HEI subsystem, Fig. 3(A), universities value *Critical thinking*, *Communication & new-media literacy* and *Excellence & sustainability* more than polytechnic institutes, and oppositely attribute less relevance to *Technical competencies & leadership*, *Complex problem solving* and *Social intelligence*.

Looking at the employers working skills rankings, one could argue that polytechnic institutes are more aligned with the professional world requirements.

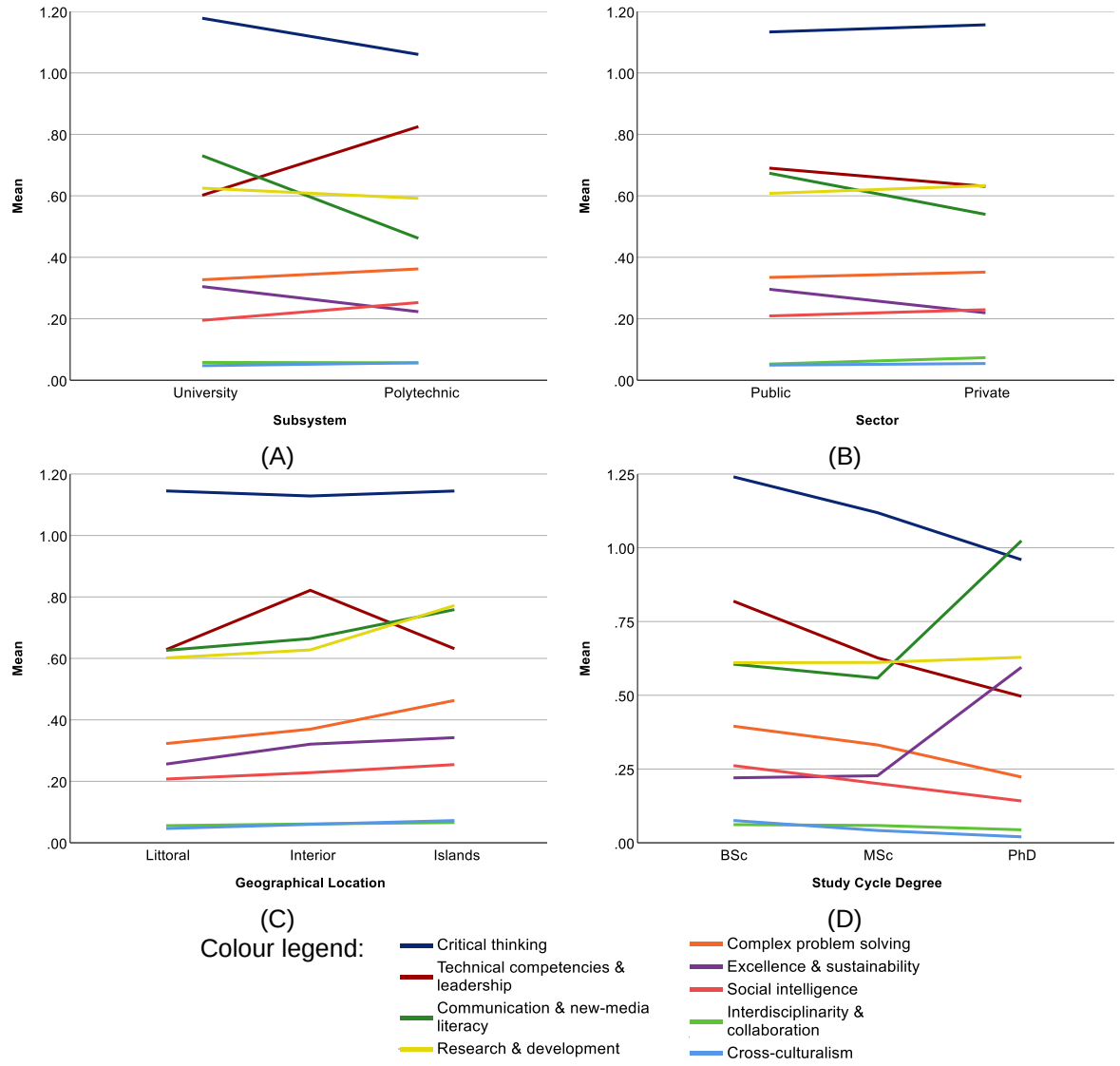

Figure 3. Relative importance attributed to each HEC by (A) HEI subsystem, (B) HEI operating sector, (C) HEI geographic location and (D) SP study cycle degree.

There are no significant differences in the relevance attributed to main HEC by public and private universities, Fig. 3(B), apart from small variations in *Communication & new-media literacy* and *Excellence & sustainability*, which follow the same trend as in the university/polytechnic analysis, and that may inclusively be biased by the much larger proportion of universities operating in the public sector. This indicates that, in Portugal, public and private HEI are offering the same type of employees to the world of work, with no distinctive competencies.

Regarding geographical location, Fig. 3(C), it is worthwhile mentioning the higher relevance clearly attributed to *Technical competencies & leadership* in the interior region. This can be partially biased by the fact that the interior regions contain a higher percentage of polytechnic institutes (45%) than the littoral (30%). However, since polytechnic institutes exist in a much lesser number (33%, Table 3), this difference is noteworthy.

The larger differences are observed when comparing the different SP degrees, Fig. 3(D), in particular 3rd cycle degrees. The relevance attributed to *Communication & new-media literacy* and *Excellence & sustainability* is clearly higher in PhD programmes, showing, as in the case of HEI university subsystem, the more academic nature of the HEC addressed in these study programmes. Furthermore, almost all the other HEC (except *Research & development*) are less relevant in PhD curricula than in any other

study cycle degree programmes. In fact, there is a gradual decrease in the relevance given to all these competencies with the increase in the submitted programme degree. Probably because it is already expected that students have acquired those competencies in previous study cycles.

Finally, when comparing the relative importance given to top 5 ranked HEC with the scientific area of the SP, Fig. 4, some findings are worth mentioning.

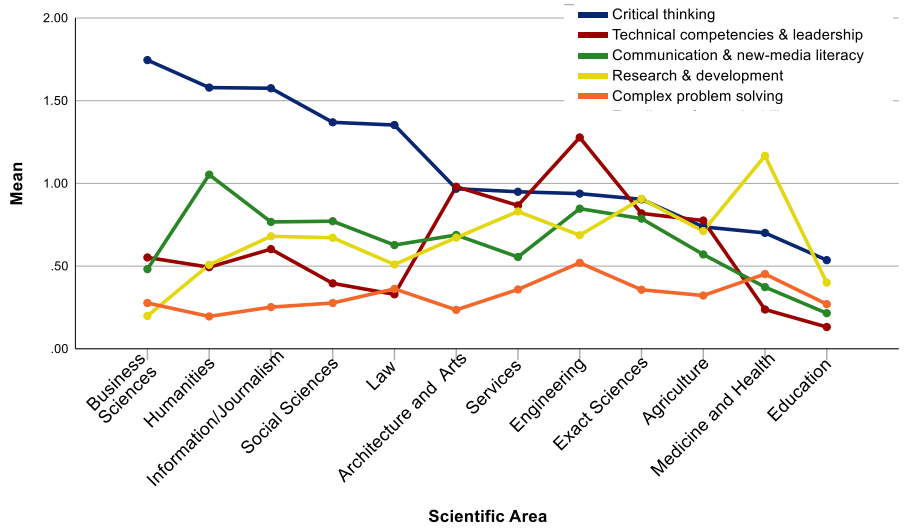

Figure 4. Relative importance attributed to each HEC by scientific area of the SP. For clarity of information, only the top 5 ranked HEC were included.

First, there appears to be an almost opposite trend discriminating "social sciences" (e.g. business, humanities, communication, social sciences, architecture, arts and services) from "applied" (e.g. engineering, agriculture, medicine and health) and "formal sciences" (e.g. exact sciences). This trend is marked by a decrease in the relevance attributed to *Critical thinking* and a simultaneous increase in the relevance attributed to *Research & development*. Such opposite trend seems an antagonism and may reflect a divergence in the academic language used by the different science branches when writing study programmes learning outcomes. This is the type of language mismatches that can confuse both employers, HEI quality assessment entities and students, and the gap is more pronounced in "social sciences" (namely business sciences). Second, the relevance attributed to *Technic competencies & leadership* follows an opposite but natural trend, with higher expression in more technical study programmes related to "applied" and "formal sciences". Third, one of the most professionally valued skills, *Complex problem solving*, is generally more valued in engineering and in medicine and health study programmes ("applied sciences"). Lastly, education seems an exception to any observed trend. It ranks lowest in almost every HEC (exceptions are *Complex problem solving*, *Social intelligence*, *Cross-culturalism* and *Interdisciplinarity & collaboration*). Such findings traduce some disregard attributed by HEI offering SP in this scientific area in what concerns writing learning outcomes, and it may be related to the close employer-employee circuit perceived in education related professions. Two other incongruities that deserve mention (data not shown) are the low relevance (mean citation of 0.08) attributed by law SP to *Social intelligence* and the null relevance attributed by information/journalism SP to *Interdisciplinarity & collaboration*.

CONCLUSIONS

A principal component analysis allowed the association of thirty higher education learning outcomes (identified in all the Portuguese study programmes curricula official documentation) with nine core academic skills, which were linked to current world of work skills requirements. The nine higher education competencies were cross-analysed with several distinct features of the higher education study programmes (study programmes and scientific area) and institutions (geographical location, university/polytechnic subsystem, and private/public sector). The mismatches and incongruities found can be used to pave the way for redesigning the existing learning outcomes, or even consider future learning outcomes to include in academic curricula, contributing to interconnect the academic offer with the professional demand.

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