Signals from Academic Hiring: A Decade of Skill Demands at a Danish University

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Abstract

The rapid emergence of Generative AI (GenAI) is transforming labor market expectations and prompting a re-evaluation of skill priorities in higher education. This study investigates how academic skill demands have evolved over the past decade by analyzing job postings from a major Danish university (2013–2023) using natural language processing (NLP) and statistical modeling. Leveraging the ESCO taxonomy, we extract and classify skills into digital, research, and transversal categories. Our findings reveal a recent shift in hiring strategy towards fewer but more skill-intensive roles, a declining emphasis on digital skills, and a rise in research-oriented skills. Additionally, we observe significant disciplinary variation, with Engineering emphasizing digital skills, while Social Sciences prioritizing research competences. In the Humanities, emerging skills increasingly reflect demands in societal engagement and digital literacy. These results offer data-driven insights into the alignment of curricula with evolving labor market demands in the GenAI era.

1 Introduction

The rapid rise of Generative Artificial Intelligence (GenAI), exemplified by the launch of ChatGPT in late 2022, has profoundly impacted educational landscapes and the global labor market (Adiguzel et al., 2023; Johnson et al., 2021). As AI tools increasingly assist – or even automate – complex intellectual tasks, educators around the world are grappling with fundamental questions: *What skills should we teach to help students thrive in an AI-driven world?* Much of the current educational research has focused on supply-side adaption. A growing body of research has underscored the importance of cultivating AI literacy across disciplines (Ng et al., 2021), highlighting skills such as prompt engineering (Walter, 2024), computational thinking (Weng et al., 2024; Dohn et al., 2022), critical thinking(Muthmainnah et al., 2022). While these contributions are vital, one crucial question remains underexplored. *What does the labor market expect from future graduates in the age of AI?* This study addresses the question from the perspective of employer demand. We examined academic job postings from a major Danish university between 2013 and 2023 using natural language processing (NLP) and statistical modeling. By tracing how skill requirements have evolved over time and across disciplines, our aim is to provide evidence-based guidance on the skills that academic institutions may need to prioritize to prepare students for the GenAI era.

2 Literature Review

Globalization and digitization are reshaping labor markets, with AI emerging as a key driver for workforce transformation (Johnson et al., 2021). According to *European Center for the Development of Vocational Training* (Cedefop, 2023), nearly half of European adult workers encountered new digital technologies in their workplaces during 2020-2021, with 35% needing to upskill. The *World Economic Forum* (2025) similarly projects that 39% of core skills will change by 2030, driven by advances in automation, AI integration, and digital transformation.

In this evolving landscape, demand is rising for both *technical skills* – such as AI and big data, and digital literacy – and *transversal skills* including resilience, flexibility, and leadership. Research in labor economics reinforces this dual emphasis in the AI-driven labor market. On the technical side, skills in machine learning, natural language processing, computer vision, big data analytics, and programming are widely recognized as essential for AI development and application (Alekseeva et al., 2021; Johnson et al., 2021). Equally important, employers are also increasingly valuing transversal skills such as adaptability, resilience, and creativity

(Babashahi et al., 2024; Asylbekova et al., 2023). These human-centric skills are considered more resistant to automation and are critical for navigating dynamic, AI-infused work environments (Poláková et al., 2023; Belchior-Rocha et al., 2022).

Despite these findings, a recurring concern in the literature is the growing mismatch between skill supply and demand (Basson et al., 2023; Singh Dubey et al., 2022; Pater et al., 2022). Employers across sectors face significant challenges in recruiting employees with the right combination of technical and transversal skills to harness the full potential of AI (Sidhu et al., 2024). In addition, most existing studies focus primarily on the private sector of information and communication technology (ICT) and rely heavily on data from the US labor market (Babashahi et al., 2024; Johnson et al., 2021), limiting their relevance to other sectors and national contexts.

This study addresses these gaps by shifting focus to the public sector - specifically academic employment in Denmark, a highly digitalized country with robust labor market data. Academic job markets are of particular interest because they encompass a wide range of disciplines, from engineering and health sciences to the humanities and social sciences. Moreover, they serve a dual function: both responding to labor market demands and influencing future skill supply through hiring decisions, curriculum development, and research priorities.

3 Research Aim and Questions

This study aims to examine how skill demands in academic employment have evolved over the past decade in response to technological change. We analyze academic job advertisements from a major Danish university between 2013 to 2023. Using the European Skills, Competences, Qualifications and Occupations (ESCO) taxonomy, we extract specific skills mentioned in each job ad and classify them into three broad skill types:

- **Digital skills** – Technical and computational competences, such as programming, data analysis, and proficiency with digital tools;
- **Research skills** – Analytical, investigative, and discipline-specific competencies central to academic inquiry;
- **Transversal skills** – Interpersonal and cognitive skills such as communication, teamwork, adaptability, and problem-solving.

By tracking changes in both individual skills and skill types over time and across academic disciplines, the study offers empirical insights into how skill demands in academia have evolved. It also offers data-driven guidance to align curricula with emerging labor market needs. The study was guided by the following research questions:

1. How have the volume of academic job ads and the average number of skill requirements per ad changed over time? What is the relationship between these two trends?
2. How have demands for digital, research, and transversal skills evolved over the past decade in academic hiring?
3. Are there significant differences in mean skill demands across faculties and over time, both within and across the three skill types?
4. Which specific skills are growing and declining in demand over time, both across all faculties and within the humanities in particular?

4 Methodology

4.1 NLP: Skill Extraction and Classification

We developed an end-to-end pipeline to extract and classify skills from unstructured job advertisements based on ESCO taxonomy. The pipeline involved six stages: (1) data collection and preprocessing, (2) taxonomy alignment and encoder selection, (3) retrieval-augmented supervision with a large language model (LLM), (4) multi-objective fine-tuning of a sentence encoder, (5) normalized skill distribution at the job-ad level, and (6) evaluation. An overview is shown in Figure 1.

The pipeline began with web scraping of over 3 million Danish job ads from Jobindex, Denmark's largest job portal. We processed the data to isolate skill-relevant content through HTML parsing, regular expressions, and sentence segmentation. For each sentence, we generated semantic embeddings using the multilingual sentence encoder *paraphrase-multilingual-mpnet-base-v2*. We then retrieved the 25 most similar ESCO skills based on cosine similarity. These candidate skills were embedded into structured prompts used to query GPT-4o mini, which determined whether the sentence expresses a skill requirement and, if so, which ESCO skills are relevant. This retrieval-augmented prompting procedure resulted in more

than 536,767 labeled sentences, covering 76.7% of ESCO's 13,896 skills. Our approach represents a novel contribution to the NLP community by combining dense sentence embeddings, retrieval-based skill alignment, and LLM-based labeling in a semi-supervised pipeline for domain-specific skill extraction.

To improve sentence representations for skill recognition, we fine-tuned the sentence encoder using a multi-objective loss function: (1) a binary classification task to predict whether a sentence contains a skill, and (2) a ranking loss to align sentence embeddings with relevant ESCO skill embeddings. Fine-tuning incorporated stratified sampling, layer-wise learning rate decay, and early stopping based on ranking performance metrics.

Finally, each job ad was represented with a normalized probability distribution over ESCO skills. This probabilistic representation captured the relative importance of multiple skills within each ad while accounting for differences in length and verbosity. Full technical details of the pipeline's development and implementation are available in the associated methodological paper (Authors, 2025) .

4.2 Data application: Academic Job Postings in Denmark

We applied the pipeline to academic job advertisements from a major Danish university from 2013 to 2023. For each job ad, the pipeline extracted a list of relevant ESCO skills, each assigned a probability score that reflects its importance within the job ad.

To contextualize skill demand, we further enriched the dataset by identifying both faculty affiliation and position type. Faculty information was extracted by scanning the job descriptions for predefined keywords (e.g., "faculty of humanities", "humanistiske fakultet"). Through a keyword-matching function, each job was assigned to one of the five faculties or labeled as *unknown* if no match was detected. A similar rule-based approach was used to determine position types (e.g., "assistant professor", "postdoc", "PhD") based on keyword detection.

Based on ESCO's taxonomy, we then assigned each extracted skill to one of three predefined skill types: *digital, research, or transversal*. Skills falling outside these categories were labeled as *other*. This structured classification enabled us to conduct statistical analyses of skill demand evolution over time, and across faculty and academic position.

4.3 Statistical Analysis

To address RQ3, we used a linear mixed-effects model (LMM) to assess how average skill demands per ad have changed over time across faculties and skill types. LMMs are well-suited for hierarchical data, as they accommodate both fixed and random effects and allow for repeated observations within groups (Gelman and Hill, 2021). The dependent variable was the mean number of skills per job ad. Fixed effects included year, faculty, and skill type, along with their two-way interactions (i.e., year × faculty, year × skill type, faculty × skill type). Random intercepts were specified for each faculty × skill type combination. Model estimation used restricted maximum likelihood (REML) and Satterthwaite's approximation for degrees of freedom.

To address RQ4 on identifying growing and declining skills, we analyzed longitudinal trends in the relative frequency of skill mentions. For each year from 2013 to 2023, we calculated the proportion of job ads mentioning each skill. We then used ordinary least squares (OLS) linear regression to estimate the slope of change over time. A positive slope indicates increasing demand (growing skill), while a negative slope signals decreasing demand (declining skill). This trend analysis approach aligns with established practices in time-series modeling (Montgomery et al., 2021).

5 Results

5.1 RQ1: Job volume and skill intensity over time

Figure 2 illustrates notable fluctuations in job volume and average number of skills per job ad from 2013 to 2023. Between 2016 to 2020, number of job postings increased steadily, peaking in 2019. Meanwhile, the average skill demand per ad dropped sharply in 2016 and gradually rose again through 2019. This pattern suggests that, during periods of strong hiring demand, employers may have relaxed skill requirements to attract a broader application pool.

In 2021, job postings declined sharply, largely due to the COVID-19 pandemic. However, the average number of skills per ad remained stable and even slightly increased, indicating a shift toward fewer but more skill-intensive job positions. From 2022, job volume began to slowly recover, while av-

erage skill requirements per ad rose sharply, reaching their peak in 2023. This divergent pattern implies a transition toward more selective and skill-intensive hiring practices.

5.2 RQ2: Evolution of skill type

Figure 3 presents trends in the average number of skills per ad, categorized by ESCO's three skill types: *digital, research, and transversal*. Between 2013 to 2019, digital skills were the most frequently mentioned skill type in job ads, peaking in 2019. However, their prominence declined sharply thereafter. Meanwhile, research skills remained relatively stable until 2020, then increased steadily and surpassed digital skills by 2022. Transversal skills remained consistently low throughout the period, with only a modest increase after 2021. These trends suggest a shift in hiring priorities from digital proficiency toward research-oriented expertise.

5.3 RQ3: Differences by faculty and skill type over time

LLM results revealed significant variation in skill demands by faculty and skill type, with important interaction effects over time. While the main effect of year was not statistically significant (p=0.53), interactions between year and faculty (p=0.49), and between year and skill type (p=0.22) were also not statistically significant, suggesting limited evidence that temporal trends differ across disciplines or skill types.

Across the full-time span (2013–2023), digital skills were the most emphasized (M = 3.02), followed by research skills (M = 2.28), and then transversal skills (M = 0.25). All pairwise differences between skill types were statistically significant ($p < .001$, Bonferroni-adjusted). The faculty × skill type interaction was also highly significant ($p < .001$), showing distinct disciplinary profiles: Engineering emphasized digital skills most strongly, while Social Sciences prioritized research skills. The Humanities and Natural Sciences exhibited relatively balanced, but lower overall skill intensities. Detailed trends are shown in Figure 4.

5.4 RQ4: Growing and declining skills

To identify long-term trends in specific skill demands, we ranked all extracted skills by the slope of their linear trend from 2013 to 2023. The top 10 skills with the most positive and most negative slopes were classified as growing and declining skills, respectively. This analysis was conducted for both the full dataset and a subset focused on humanities faculty (Figure 5 and Figure 6).

In the humanities, emerging skills included "apply knowledge of social sciences and humanities," "web analytics," and "media studies"—all of which reflect a growing demand for interdisciplinary, data-informed, and applied research competencies. Conversely, declining skills included more traditional academic and administrative tasks, such as "assist students with their enrolment" and "contribute to specialised publications". These patterns suggest a reconfiguration of academic roles toward greater societal engagement and digital literacy.

6 Discussion

This study examined how skill requirements in academic job postings have evolved over the past decade in response to technological change. The findings offer several key insights relevant to curriculum development and institutional strategy.

The analysis of job volume and skill intensity reveals a shift in hiring strategy. While the number of academic positions has declined since the pandemic, the average number of skills required per job has increased, particularly after 2022. This suggests a move toward more selective recruitment, with greater emphasis on multi-skilled candidates.

Trends in skill types indicate a significant change in hiring priorities. Digital skills, once dominated, have declined in emphasis since 2020, while research skills becoming more prominent. This shift may reflect an institutional assumption that basic digital literacy is now a baseline expectation, with greater value placed on disciplinary depth and research capability.

Faculty-level analysis highlights the need for discipline-specific strategies. Engineering continues to prioritize digital skills, while Social Sciences emphasize research competencies. The Humanities and Natural Sciences show lower overall skill intensities, with more balanced distributions. At the same time, the identification of growing and declining skills provides concrete evidence of how academic expectations are shifting.

While this study draws on job postings from only one major Danish university, such postings serve as a clear demand-side signal that can guide curriculum review. They make explicit the competencies institutions prioritize in recruitment—whether discipline-specific research expertise, technical skills, or transversal abilities. These signals can

support curriculum decision-making in several ways: (1) highlighting skills that are in demand but underrepresented in existing courses; (2) identifying emerging competencies that could be incorporated into electives or interdisciplinary modules; and (3) providing evidence to inform program evaluation, accreditation, and strategic planning.

These findings also underscore the importance of systematically tracking emerging skills—especially in the current AI-driven era, where technological capabilities and work practices evolve at unprecedented speed. University curricula, constrained by structural factors such as accreditation cycles, lengthy program approval processes, and institutional governance, often lag behind the pace at which AI-related competencies emerge. Longitudinal analysis of skill trends, such as that presented here, can serve as a strategic foresight tool: rather than prompting reactive changes to every short-term fluctuation, it can help identify persistent, multi-year patterns that signal more durable shifts in competence demand. By distinguishing between fleeting spikes and sustained trends, institutions can prioritize curriculum updates that are both timely and resilient, equipping students with adaptive, interdisciplinary, and AI-literate skill sets—preparing them not only to navigate but to actively contribute to the rapidly evolving landscape of the GenAI era.

Taken together, these results contribute to the ongoing debate around what skills higher education should prioritize in the GenAI era. By offering a demand-side, data-driven view of how academic skill requirements have evolved, this study provides actionable insights for aligning university curricula with labor market expectations and making educational systems more adaptive, interdisciplinary, and future-oriented.

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A Appendix

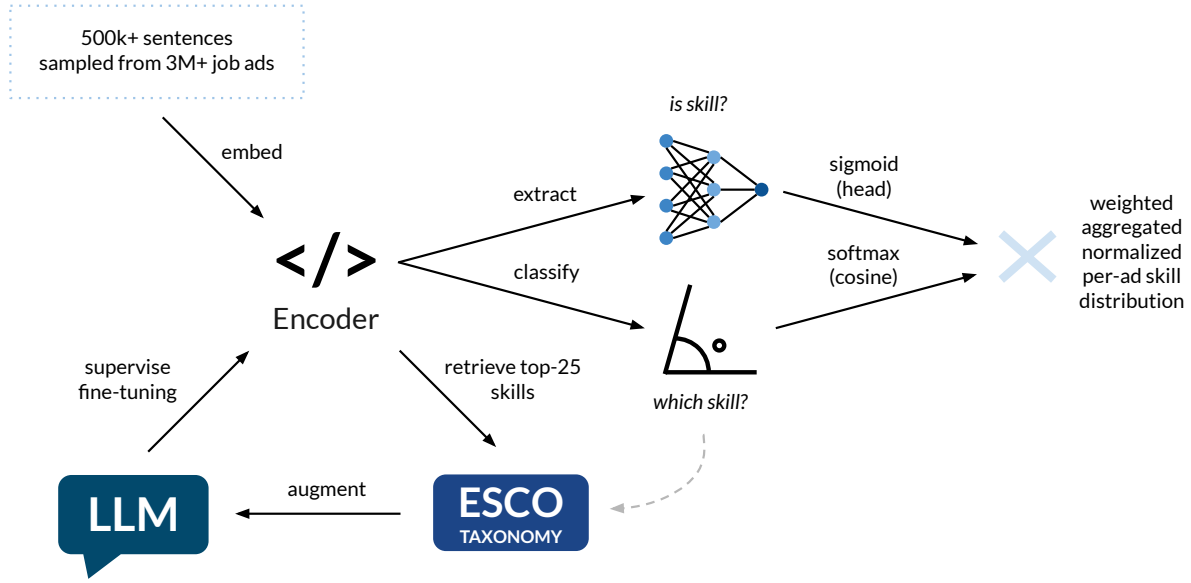

Figure 1: Overview of Our Pipeline Utilizing the Sentence Encoder Twice

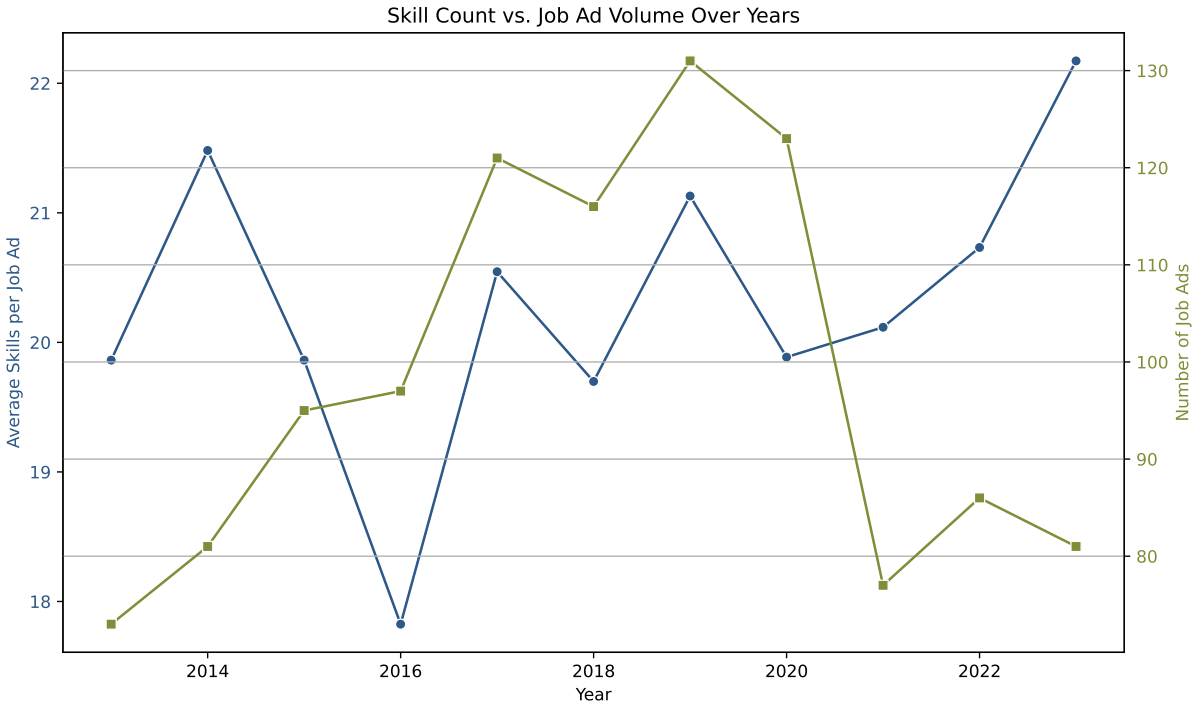

Figure 2: Job Volume vs. Skill Demand Over Time

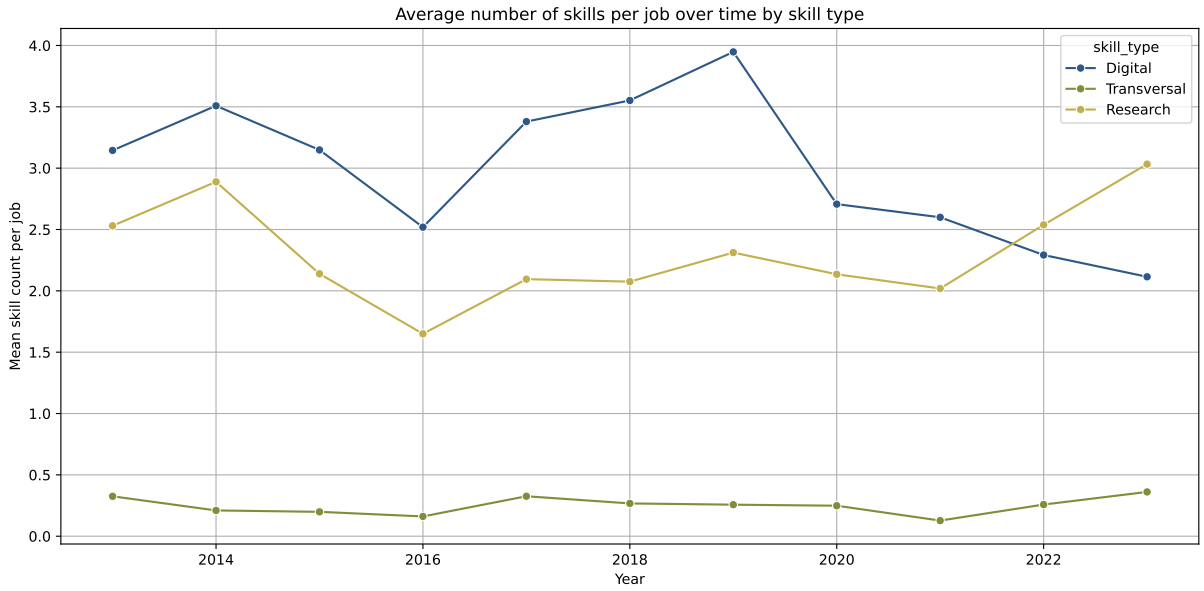

Figure 3: Average Job Demands Across Faculty by Skill Type Over Time

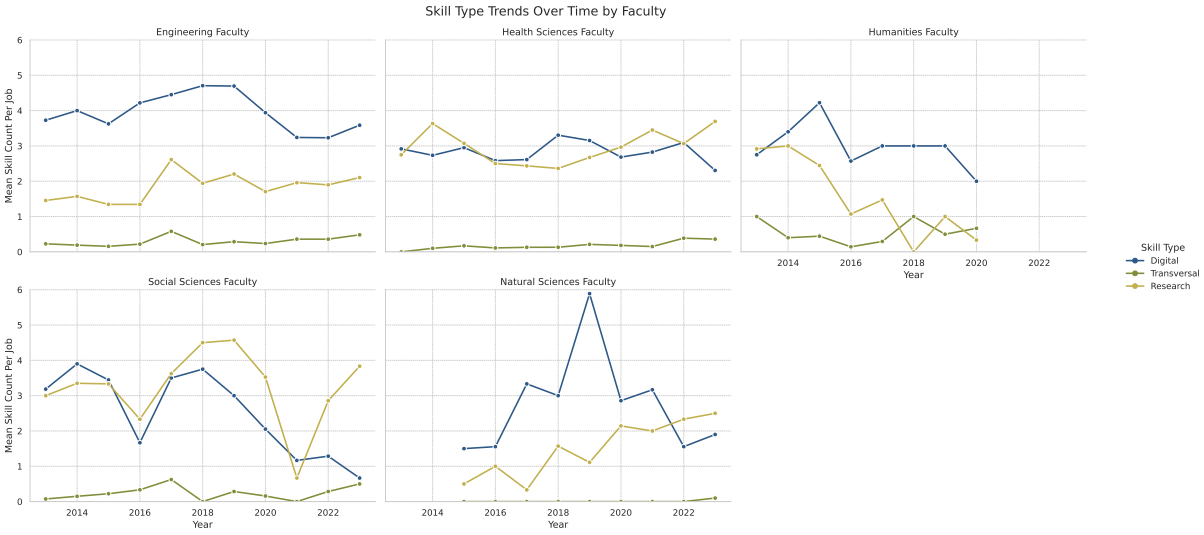

Figure 4: Skill Type Trend by Faculty Over Time

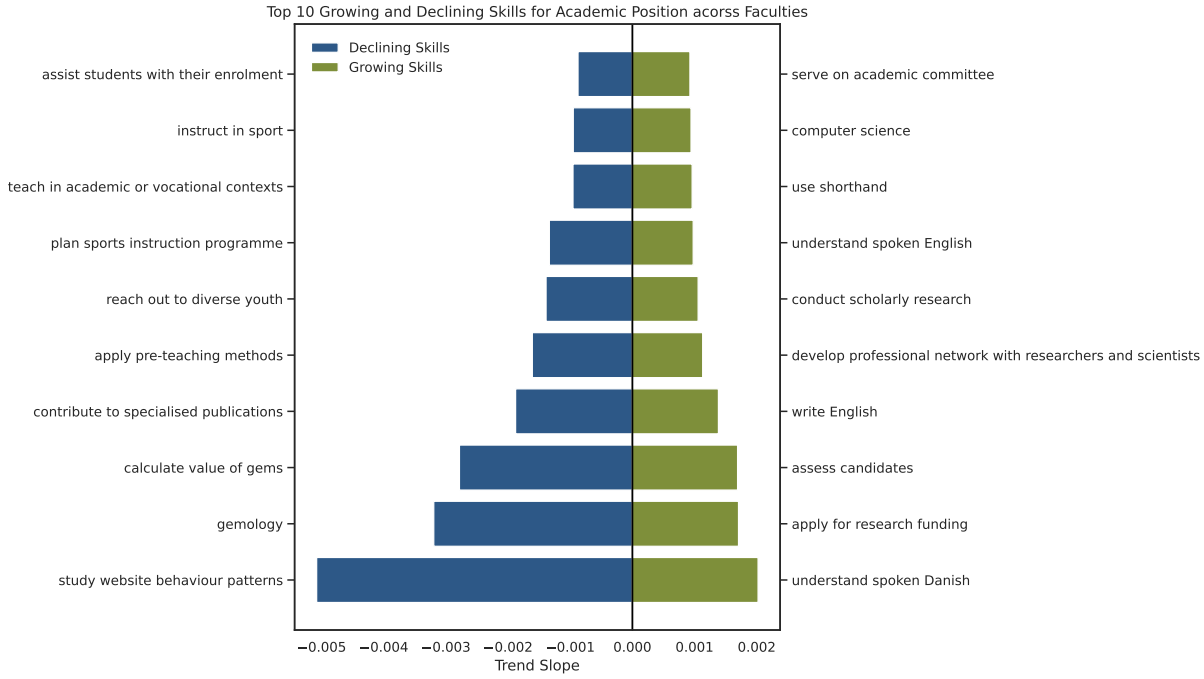

Figure 5: Growing and Declining Skills Across Faculty Over Time

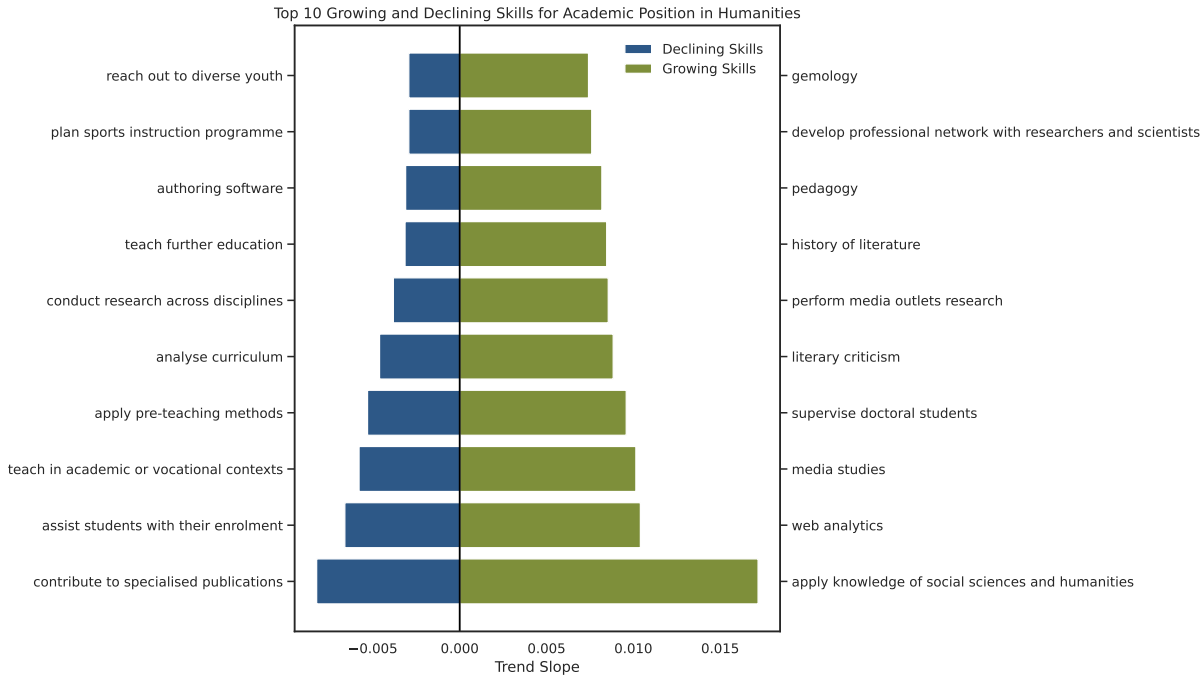

Figure 6: Growing and Declining Skills in Humanities Over Time