

Data-Driven Curriculum Design: Aligning Job Market Needs and Educational Content through Job Ad Analytics

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Abstract

Fast-paced technological development necessitates continuous adaptation of Information Systems (IS) educational programs. The challenge is to ensure the best possible match between curricula and the knowledge needs of students. The question facing educational institutions is how to ensure that graduates' competencies match the demands of the job market. Traditionally, expert panels are used to align curricula with the needs of prospective employers for knowledge and competencies. However, these panels are not representative and can even be potentially biased, depending on the interests of the participants. This study investigates the potential of using job ad analytics as a source of curriculum alignment, as seen from the perspectives of key stakeholders of two IS educational programs at Business

Academy Aarhus. The objective is to explore how job ad analytics can be utilized to ensure ongoing alignment between IS educational programs and competencies in demand in the job market. The paper describes the underlying technology, as well as how it is used, and is likely to impact both the creation of new IS educational programs and quality assurance of existing ones. This study contributes to existing research by showing how education managers, teachers, and other stakeholders involved in curriculum development and change can use job ad analytics to align supply and demand for competencies.

Keywords: IS Education, Graduate Skills, Job Ad Analytics, Competencies, Curriculum Development.

1. INTRODUCTION

Technologies are constantly evolving at a staggering pace and companies are struggling to keep up with the resulting change imperative. Consequently, there is a constant demand for new competencies, especially within Information Systems (IS), a field preoccupied with the development, implementation, and use of technologies. This poses a major challenge for educational institutions, as this constant change is difficult to maneuver when designing and adapting educational programs to supply the competencies in demand on the job market (Stevens et al., 2011).

Although the principles behind job ad analytics as a basis for developing and aligning educational programs have been described in the literature, to our knowledge, there are no empirical studies of its practical application. This study addresses this knowledge gap by examining the implications of applying job ad analytics to the curriculum alignment process.

2. LITERATURE BACKGROUND

Different approaches to developing and changing educational programs have been described in the existing literature. To investigate the link between job market needs and educational institutions' supply of competencies, existing studies primarily rely on three main methodologies: Surveys, interviews, and job ad analytics.

Surveys and Interviews

Surveys and interviews are commonly used methods when trying to align IS curricula with job market needs (Tan et al., 2018; Cummings & Janicki, 2020). Cummings and Janicki (2020) analyze the knowledge and skills needed by means of a survey among IS professionals. The study reveals a potential competency gap in IS curricula due to the increasing importance of particular technologies and the consequent demand for new programming languages. In another study, Tan et al. (2018) demonstrate an approach for aligning IS programs with business needs, in which feedback from industry

representatives is collected through individual and focus group interviews. They adapt a specific IS course to the needs of business practitioners and propose, more generally, to align IS curricula with industry needs by mapping course content to professional IT certifications. Such an alignment could enable students to obtain certificates as part of their formal education.

In a three-part study, Jones et al. examine the gap between American IS curricula and the skill needs of employers (Lang et al., 2015; Jones et al., 2018; Leonard et al., 2019). They conclude that several areas, e.g., IT security, project management, and enterprise architecture, are not receiving enough attention in contemporary IS curricula (Leonard et al., 2019). The methods used in the study reveal gaps between skills in demand and educational content, which makes them useful when revising curricula. A disadvantage of the methods in question, i.e., surveys and interviews, is their resource-intensive nature, which makes them both cost prohibitive and time-consuming to use on a regular basis.

Job Ad Analytics

Qualitative and quantitative analysis of job ads as means of identifying competencies in demand has been used in multiple studies (Gromov et al., 2020; Boehler et al., 2020). Job ad analytics has attracted attention as job ads have been digitized and migrated online. Job ad analytics takes several forms, e.g., manual text mining, automated text mining, and automated semantic text mining through machine learning.

Job Ad Analytics: Manual Text Mining

Manual text mining is done by researchers who read, code, and analyze texts, as exemplified by Woolridge and Parks (2016) and Burns et al. (2018). Both studies compare the skills needed with the 2010 ACM/AIS Information Systems Curriculum Guideline (Topi et al., 2010). Woolridge and Parks (2016) compare the degree of alignment between IS job ads and the career tracks suggested by the guidelines through a content analysis of 206 job ads and identify a gap between career tracks and job types, as well as

between the needed competencies and those taught in IS programs. One study analyzes the changes in IS competencies over a fifty-year period by looking at the evolution of curricula (Longenecker et al., 2013). Another study (Burns et al., 2018) investigates the skills needed in entry-level jobs requiring an undergraduate IS degree by analyzing job ads. The results show that employers are looking primarily for soft skills and programming. Neither is prioritized in the guidelines that need to be updated. Overall, the manual text mining approach to job ad analytics helps identify alignment gaps, but the method is time-consuming and does not guarantee that the results are representative of competency needs across the entire job market.

Job Ad Analytics: Automated Text Mining

Automated text mining reduces analysis time compared to manual text mining approaches. Automated analysis using so-called dictionaries can be used to quantify the demand for pre-defined competencies mentioned in job ads. Dictionaries can be developed through a theoretical approach (Luo, 2016; Gardiner et al., 2018) or an empirical approach (Dong & Triche, 2020). Dictionaries enable researchers to convert unstructured text into structured data by categorizing words and applying rule-based logic. Studies show that an empirical approach based on text mining is applicable when investigating the alignment between IS educational programs and the competencies in demand on the job market (Gardiner et al., 2018; Brooks et al., 2018; Dong & Triche, 2020; Verma et al., 2021), and trying to understand the evolution of competency needs over time (Litecky et al., 2012; Litecky et al., 1998; Hite, 2012). Other approaches to automated job ads analysis include machine learning (ML) and Natural Language Processing (NLP), which allow for semantic text mining of job ads despite being different artificial intelligence techniques (Altinel & Ganiz, 2018; Cambria & White, 2014; Pejic-Bach et al., 2020) through data processing (Chowdhary, 2020; Salloum et al., 2020). As an example, Pejic-Bach et al. (2020) perform an ML-based analysis of Industry 4.0 job ads to identify the required domain knowledge and skills. Debortoli et al. (2014) apply ML to identify needed big data and business intelligence skills. They develop a competency framework based on a Latent Semantic Analysis (LSA) of job ads. LSA automatically generates topics from words in the corpus of the text and considers not only the frequency of words but also their context (Sidorova et al., 2008). Similarly, Deng et al. (2016) used LSA to analyze business analyst job ads on LinkedIn. Using Bloom's taxonomy to

interpret their results, they show that existing educational programs do not meet industry demands for business analyst competencies. Furthermore, Mathiasen et al. (2023) demonstrate automated semantic matching of job ad requirements with learning objectives in curricula using NLP.

This Study

In summary, different methods are currently used to align IS educational programs with the demands of the job market. Surveys, interviews, manual and automated text mining, and machine learning approaches provide insight into competency demands. However, each method has limitations, such as small sample sizes, time-consuming analyses, or the complexity of ML approaches.

This study investigates the potential of using job ad analytics as a source of curriculum alignment, as seen from the perspectives of key stakeholders of two IS educational programs at BAAA. The objective is to explore how job ad analytics can be utilized to ensure ongoing alignment between IS educational programs and the needed competencies. By examining how job ad analytics can improve the current process of aligning the supply and demand for competencies, we aim to answer the following research question: *How can job ad analytics be used to ensure alignment between the demands of the job market for competencies and the curricula of educational programs?*

3. CASE DESCRIPTION

This research is carried out at Business Academy Aarhus (BAAA), a school of applied sciences in Denmark. BAAA provides a wide range of undergraduate programs which are vocational and primarily target the private business sector.

The study focuses on two IS educational programs: Computer Science and E-Commerce. Computer Science is an undergraduate degree program that provides skills in software programming and systems development. The program focuses on providing skills in the development, planning, programming, implementation, and use of IT systems. Computer Science graduates are typically hired as system developers, programmers, and system designers. E-Commerce is a Bachelor's degree. It is a market-oriented program that provides students with skills and knowledge in digital business know-how, e-commerce technologies, customer experience, advanced digital marketing, and data analysis. E-Commerce

graduates are typically hired as digital marketing coordinators, content specialists, and marketing assistants.

Denmark has seven business academies that cooperate in developing new programs, but are free to choose which programs to offer students. Therefore, all educational programs have a national curriculum that applies to all academies and a local curriculum that is particular to each institution. The national curriculum dictates the learning outcomes of the program. The local curriculum describes how each academy implements the desired learning outcomes, for example, which courses are offered each semester. Additionally, it contains the electives and unique courses offered by the academy. It is through electives that emerging technologies and competency needs are incorporated into the curriculum. Electives may be changed later to mandatory courses as needed. Furthermore, electives are a flexible way for BAAA to align educational programs to topical trends, as they can be written into the local curriculum annually.

However, to ensure that educational programs meet the demand for skilled labor on the job market, academies continuously try to identify which competencies are needed now and in the future.

4. METHODOLOGY

We have established that there are no empirical studies of the practical application of job ad analytics as a basis for developing and aligning educational programs. This leads to our research focusing on how to use job ad analytics to ensure alignment between the demands and supply of competencies. To address the identified knowledge gap and the research question, we conducted a multiple case study with two embedded units of analysis (Yin, 2014) to understand the practical implications of applying job ad analytics as seen from the perspective of stakeholders who seek to align educational programs and the demands for competencies of the job market.

Data Collection

The empirical data were obtained from semi-structured interviews with six different informants. We interviewed a lecturer, the head of program, and the department head of each of the two educational programs in Computer Science and E-Commerce at BAAA. While the lecturer makes day-to-day operational decisions about the course content, the head of the program has the tactical responsibility of running

the educational program on a daily basis. The department head at BAAA takes a broader strategic perspective, overseeing several programs and focusing on ensuring alignment with the job market. The informants were selected based on their role at BAAA to gain insight into how they continuously adapt programs and courses to meet competency demands.

Each informant was interviewed twice. The first interview covered the process of developing and ensuring the quality of educational programs, while the second interview focused on the use of job ad analytics as part of the process. Before the second interview, the job ad analytics tool, Jobtrend (see below), was used to identify competencies in demand in the job market by analyzing ads directly linked to the Computer Science and E-Commerce programs. The results were presented during the introduction to the second interview.

The interviews followed a semi-structured format. A separate interview guide was developed for each of the three informant roles to gain insight into the different stakeholder perspectives on the alignment between educational programs and the competencies in demand in the job market. The interview questions were based on the existing literature presented earlier. All interviews took place in March 2021 and lasted between 25 minutes and 1 hour. The interviews were conducted in Danish, recorded, and transcribed verbatim to facilitate thematic analysis. The interviews were conducted by two researchers. One researcher acted as the primary interviewer while the other researcher asked follow-up questions and encouraged the informants to elaborate answers. This process strengthened the validity and reliability of our data collection by reducing interviewer bias and the risk of misunderstandings between the informant and the primary interviewer (Miles et al., 2014).

The findings presented in Section are the result of a synthesis of the interviews conducted based on an inductive thematic analysis of their content. This thematic analysis was based on a data analysis protocol and a coding scheme developed by the researchers involved. Data were coded using the NVivo qualitative data analysis software. The 12 interviews were coded and analyzed in a two-step process (Miles et al., 2014). The first-cycle coding resulted in a summary of the data. During second-cycle coding, this summary was supplemented by a categorization of the data through pattern coding,

which helped us identify emerging themes that reflect similarities in perspectives among informants.

The Job Ad Analytics Tool Jobtrend

In this paper, we use Jobtrend for job ad analyses. The tool scrapes job ads from the major job sites Jobindex (2022) and Careerjet (2022). By continuously scraping all online ads from the two largest Danish job websites, nearly all Danish online job ads are stored in its database, which makes the data representative of all jobs on the market. The tool uses a dictionary containing 19,604 predefined and standardized competencies, which is continuously maintained and validated by the "European classification of Skills, Competences, Qualifications and Occupations" (ESCO) project (European Commission, 2022). The tool provides statistical analyses of job ads, including patterns in competency trends over time and links between competencies and job ads. Users can also perform in-depth analyses of the competencies mentioned in the job ads. For more information about Jobtrend and how to use it for analysis purposes, see <https://www.research.baaa.dk>.

5. RESULTS

Current Curriculum Alignment Process

The need for new types of candidates is primarily monitored at the strategic level at BAAA, i.e., by the heads of department when new programs are developed or existing programs are updated to meet the changing needs of the job market. The development of new programs is initiated by the different heads of departments, but influenced by external and internal experts and stakeholders. These include employers, trade associations, ministries, lecturers, and members of personal networks of employees.

To ensure alignment between educational programs and the demands of the job market, BAAA hosts an annual strategy meeting and multiple advisory board meetings to identify areas of concern and trends of the job market. At these meetings, local companies participate to discuss the topics currently being taught and the competencies needed in the future. In addition, companies are invited on an ad hoc basis to present topics of practical relevance as a means of initiating a dialogue about the needed competencies.

Last but not least, ongoing curriculum revisions are also influenced by insights from internships of students. Internships are an integral part of the final semester of students, during which they learn to apply their skills in practice. As both

lecturers and heads of program supervise students during their internship, they acquire knowledge from companies about the technologies they are using and which competencies they expect from graduates. This is a valuable input, as it is the responsibility of BAAA lecturers to translate the curriculum into specific learning objectives.

In general, informants trust the existing process because they see themselves in an ongoing dialogue with employers who hire BAAA graduates.

Curriculum Alignment Using Job Ad Analytics

The presentation of the Jobtrend tool and the results of the analysis during the second round of interviews led to several insights into the perspectives of the informants on the analysis of job ads as a basis to ensure alignment between the competencies they provide and those in demand on the job market. An informant argues that even though it is possible to ensure curriculum alignment using job ad analytics, it is a nontrivial challenge because it interferes with lecturers' lesson planning: "It can also be used as an educational tool, directed at our lecturers. It is, however, not often that the lecturers believe it is a good idea to change things" (Head of Department, Computer Science, interview 2). A lecturer confirms this interpretation and emphasizes that job ad analytics are unlikely to change the overall profile and focus of the program. The argument is that basic programming competencies will remain the same for many years to come, as has been the case in the past. However, it is in such cases where job ad analytics is useful in monitoring changing trends and needs.

The trend feature in the Jobtrend tool can be used to investigate and support arguments for needed changes. This feature allows the user to track how any competency is trending over a specified period of time. The informants describe it as useful in support of decisions on what to include in lesson plans, as it helps determine whether something is just a buzzword or something more substantial with actual demand for related competencies. Being able to identify trending technologies and competencies allows their implementation into programs, which in turn results in graduates being better equipped for the job market. Likewise, the tool can be used when deciding what to phase out from lesson plans, as it also shows declining demand for competencies. The informants like being able to confirm or dismiss assumptions that certain competencies

are no longer relevant. The difficulty in deciding what to include and exclude in lesson plans is a constant challenge, and having job ad analytics capabilities as a firm statistical basis for decision-making is seen by the informants as a welcome supplement to the existing process.

Additionally, the informants noted that many of the top 20 competencies listed are not representative of what is taught in the programs. The majority of them can be described as soft skills (Kechagias, 2011), e.g., communication and teamwork. Although these competencies are not part of neither lesson plans nor curricula, the interviews show that soft skills are important to graduates' employability. From the perspective of students, these skills can seem trivial and even unimportant even when lecturers tell them otherwise. In continuation of this, some informants also question whether the discrepancy between the terminology used in job ads and curriculum renders the possibility of identifying competencies that are supplied but not demanded useless. They argue that job ads do not mention certain learning objectives (found in curriculum), since many of the competencies that graduates need are implied by the job title and not specified in job ads.

At the operational level, the informants stress the usefulness of the tool in establishing a bird's eye perspective on the competencies in demand in the job market as a stepping stone for in-depth investigations with the goal of redesigning or updating the lesson plans around the needed competencies. As the competencies identified through job ad analytics draw on representative data, it is perceived as a solid basis for developing lesson plans and a welcome supplement to the current curriculum alignment process. The informants express particular excitement about the feature that allows job ad analytics users to search for competencies that are in demand but not covered by the curricula. An informant elaborates:

"The interesting thing is if there are any competencies that we have missed. Are there some things where you could say that Jobtrend shows something different from what we thought was needed? And that is where it becomes interesting. That is, it becomes interesting when we were wrong..." (Lecturer, Computer Science, interview 2)

One of the informants proposes an iterative process in which stakeholders continuously revisit the competencies in demand that are not covered

by the curricula. As part of this process, the context of a given competency is reviewed to determine whether it is relevant to BAAA graduates and hence the curricula. Another informant suggests using this feature as a supplement to annual strategy meetings during which companies advising BAAA have the opportunity to support the analysis results. The tool may also provide useful input to the decision on which elective courses to offer students:

"It is a relatively quick way to calibrate a program to direct it toward some of the new trends. In that way, the database could be very relevant; to check what is trending right now, for example, machine learning or mobile phones?" (Head of Department, Computer Science, interview 2)

Similarly, job ad analytics can help BAAA respond quickly and flexibly to rising graduate unemployment through newly designed elective courses that can be used to pivot educational programs in new directions. An approach is to look for similar but more attractive professions (from the perspective of job market demand), for example, by filtering job ads by the most popular "data technician" instead of "data scientist." Because job ad analytics supports the examination of competencies needed by these data technicians, the result can be used to develop elective courses that meet competency demands:

"...we would try to hit it spot-on, offering elective courses that foster graduates who possess the competencies in demand. Where the jobs are, you know? Then, our students would stand a greater chance. That is for sure." (Lecturer, Computer Science, interview 2)

Thus, job ad analytics can be applied to quickly and flexibly change the competency profile of graduates to make them more attractive within adjacent professions.

Applying Job Ad Analytics

In addition to ESCO competencies, the Jobtrend dictionary contains competencies derived from the educational programs' curricula. To ensure its accuracy and relevance, informants suggest that the dictionary be validated by stakeholders in educational programs who have the necessary vocational knowledge (i.e., the lecturers).

When it comes to further developing the dictionary, some informants question whether the

terminology used in job ads can be used as a basis for identifying competency gaps in curriculum and lesson plans. They point to the risk that the identified competencies are too generic to adequately represent the jobs that graduates apply for, not least because ads often emphasize soft skills.

However, the informants agree that job ad analytics is a valuable supplement to the current curriculum alignment process. The applicability of job ad analytics may vary across organizational levels at the academy. At the tactical level, they believe that job ad analytics helps ensure the quality of educational programs by lending support to claims or hunches regarding trending technologies and competencies. Thus, job ad analytics complements the current alignment process by enabling quantification of competency demands.

At the strategic level, the department heads find job ad analytics useful for analyzing and documenting the demand for new educational programs. Job ad analytics supports their discussions with the government, as it provides them with statistics and numbers that can be used to show the existence of competency profiles on the job market that do not have corresponding educational programs. Therefore, it is seen as a useful tool when trying to secure government approval for new curricula. It can be used similarly in the analyses of existing programs, since the department heads are required to regularly document the demands of BAAA graduates.

6. DISCUSSION

This study investigates job ad analytics as a means of aligning supply and demand for competencies.

The current qualitative approach to aligning IS curricula with job market needs at BAAA ensures detailed input from key stakeholders but provides a narrow perspective due to the relatively few people involved. As such, the current approach is similar to the methods described in the section "Surveys and interviews" (e.g., Tan et al., 2018; Cummings & Janicki, 2020). There is therefore uncertainty when it comes to the reliability of the information on which changes are made to the curricula and whether it reflects broader competency trends. As shown, the close dialogue with local companies is seen as strengthening the curriculum alignment process by lecturers, program heads, and department heads. However, the limited number of companies that provide

input is problematic and collecting additional input is time-consuming and infeasible. Furthermore, the lecturers are responsible for keeping up to date with the latest developments and knowledge within their respective vocational areas and continuously revising lesson plans to meet the changing competency demands of the job market. They try to cope by following co-called market leaders on LinkedIn and other media, engaging in dialogue with student internship companies, using their personal network, attending conferences, and working as consultants in their spare time.

In this case study, we use Jobtrend, a tool with a unique dictionary of competencies that shares many similarities with the theoretical and empirical job ad analytics approaches described in the existing literature (Luo, 2016; Gardiner et al., 2018; Dong & Triche, 2020) in the sense that it relies on both predefined ESCO competencies and competencies grounded in the curricula of the educational programs at BAAA. While studies by Woolridge and Parks (2016) and Burns et al. (2018) point to alignment gaps between competencies in demand and those described by the 2010 ACM/AIS Information Systems Curriculum Guideline (Topi et al., 2010), they do not consider competing interpretations and interests of different stakeholders. As shown by our study, these interests influence the process of aligning and changing curricula. Our investigation also shows that alignment gaps should not automatically result in changes in curricula because curricula often use generic terms and vague language to give lecturers the flexibility to design lesson plans that meet learning objectives. Our study, therefore, contributes new knowledge and suggests that alignment gaps identified through job ad analytics require further investigation before tools like Jobtrend can be fully integrated into curricula development and change processes.

As the informants argue, it is important to bear in mind that the curricula are intentionally described at a high level of abstraction to avoid constant rewriting. This leads to generic competencies that are challenging to interpret when trying to align them with the demands of the job market. Although some relevant competencies are identified (e.g., SQL, C, and social media), they are described as too generic to be useful in the curriculum alignment process. However, despite reservations, the informants believe that job ad analytics can compensate for the shortcomings of the qualitative approach described above and provide input to the internal discussion around the change and development of educational

programs by quantifying competency demands. They argue that by helping to identify trends in competency demands and the resulting gaps in educational programs, job ad analytics may help uncover new competency profiles that are needed on the job market, but currently not catered to by existing programs.

This study exemplifies how job ad analytics can be used to ensure alignment between the job market demand for competencies and the educational program curricula and that there are many potential benefits in augmenting the existing process by integrating job ad analytics tools like Jobtrend. As a practical implication it can be argued that it is beneficial to educational programs to draw on both stakeholder input and job ad analytics through tools like Jobtrend to ensure alignment between the curriculum and job market demands. A tool like jobtrend can be used by education managers, like heads of educational programs, to align educational offerings with changing competency demand patterns in the job market, which means that it is applicable both when designing and adapting programs to labor market needs. Teachers can also make use of the tool as revealed by our analysis to identify and respond to emerging technologies and topical trends. It can help determine whether a major revision of the course content is needed or minor changes to the lecture plan and syllabus are enough to ensure the relevance of a course. However, the informants emphasize that the usefulness of the tool depends on a subsequent dialogue between stakeholders and discipline-specific translation of identified competencies (for example, when competencies are too generic to incorporate into the curriculum).

Future research should investigate the prerequisites, barriers, and success factors in the use of it by educational institutions to align their supply of competencies through educational programs with the demand for skilled labor on the job market. To this end, empirical studies of the implementation of job ad analytics in existing curriculum alignment processes are needed to demonstrate its value and use. Research is also needed to investigate the impact of the demand for soft skills on curriculum design and its revision (i.e., curriculum alignment). The informants observe that soft skills appear more often in job ads than expected, which has implications for the use of job ad analytics. Furthermore, some informants assert that certain learning objectives, which are described in the curriculum, are not mentioned in job ads because many of the competencies that graduates need are implied by the job title and therefore not specified. Future

research should, however, investigate this, for example, through interviews with companies posting job ads. Such interviews can shed light on implicit assumptions and the degree to which job ad texts reflect the actual demand for IS competencies. Finally, informants point to the lack of contextual understanding as a potential problem in interpreting the results of the job ad analytics. The existing literature presents semantic analysis methods, e.g. LSA (Debortoli et al., 2014; Deng et al., 2016) and LDA (Föll et al., 2018), which may be used to investigate and solve this particular problem related to the use of job ad analytics.

7. CONCLUSIONS

The purpose of this paper is to investigate how job ad analytics can be used to ensure alignment between the demands of the job market for competencies and the curricula of educational programs. IS studies of this topic are based on three methodologies: Surveys, interviews, and job ad analytics. Although the principles behind job ad analytics as a basis for developing and aligning educational programs have been described in the existing literature, this multiple case study examines the practical implications of applying job ad analytics to the curriculum alignment process across two educational programs. The interviews show that job ad analytics can support the continuous alignment of curriculum with the demands for competencies. The informants see value in job ad analytics and the insights into job market trends that it provides. Job ad analytics can provide the means to pivot an educational program in the face of changes in the job market. Our findings show that job ad analytics is most useful when results in the form of competency analyses are detail-oriented and context-specific. Jobtrend, a job ad analytics tool, allows continuous and automated monitoring of competencies in demand on the job market and provides valuable input to the alignment of educational programs.

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