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An Integrative Model of AI Competencies for Business Students and Where to Acquire Them

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Research Paper

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Abstract. Today, value is created by making use of technologies based on artificial intelligence (AI) in almost all parts of the value chain. Business students need to acquire AI competencies to unleash the full potential of AI in organisations. Therefore, institutions of higher education need to teach AI to business students. The present research aims to identify which AI-related competencies are relevant for business graduates and which courses exist to teach respective skills. To this end, we firstly provide a comprehensive overview of the AI competence demand in today's business world by means of a literature review and a qualitative study. Secondly, we conduct a quantitative study to analyse the curricula of leading universities and online platforms providing AI teaching. The results reveal an AI competence model for business students, an overview of current curriculum offers, and the gaps in current curricula.

Keywords: Artificial Intelligence, AI competencies, Higher Education, AI curriculum, Business Students

1 Introduction

Economic development is increasingly geared towards the digitalisation of business processes to assert in the global competition for sales markets (Dörr et al., 2021, Kagermann, 2015). Across industries, value is created more and more by making use of technologies based on artificial intelligence (AI) (Wamba-Taguimdje et al., 2020). The term AI is used as an umbrella term that encompasses a variety of different technologies which enable machines to mimic human intelligence. As a result, AI applications can nowadays perform tasks that used to require human intelligence. Utilising AI technologies in organisations promises efficiency gains and is crucial for staying competitive. However, to make profitable use of AI in today's techno-centric business world, organisations need employees with AI competencies (Åström et al., 2022). Ideally, employees have both the required technical knowledge and the

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necessary business skills. In reality, such employees do not always exist. Therefore, the missing skills should be acquired. In this paper, we focus on business students as well as on information systems students and industrial engineering students with business courses; all of them need to be able to integrate their domain knowledge with AI principles. Due to the business-related nature of these degree programmes, all of the above students are referred to as business students for the sake of simplicity. Graduates of these programmes need fundamental AI knowledge to understand AI-enriched business processes and to be able to transform current developments into business value in a value-adding way. In addition to technical expertise, knowledge is required of how to evaluate, operate and manage technical systems in organisational processes and working environments on a permanent basis. To perform such tasks, it is crucial for business students to have an opportunity to acquire such competencies (Chen, 2022). However, as of now, there is no clear framework that integrates relevant AI competencies focusing on business students with courses that are offered at higher education institutions.

The aim of this research is twofold. Firstly, we analyse which AI competencies are relevant for business students to meet the requirements of today's business reality (i.e., demand analysis). Secondly, we provide an overview of the status quo of teaching AI competencies in higher education and identify gaps (i.e., market analysis). The following two research questions will thus be answered: *(1) What are relevant AI-related competencies for business students?* and *(2) To what extent do universities meet the current demand?*

Two studies were conducted to answer the research questions, namely (1) a literature review paired with a qualitative study and (2) a quantitative market analysis. The first study (1) represents the basis for our AI competencies model for business graduates. In contrast to existing competencies models, the AI competencies are specifically geared towards business students and aligned with the current demands in the workplace. The model offers a comprehensive overview of relevant AI competencies for business students and their interrelationships. In our second study (2), AI courses offered by the top-ranked universities in the Times Higher Education (THE) ranking, online learning platforms and selected universities are analysed and categorised to find out to what degree AI competencies are covered and what kind of competence types of AI knowledge are being taught. Considering different platforms provides important insight to the question whether certain competencies are more likely to be represented or underrepresented in certain outlets. Finally, we highlight possible gaps between supply and demand and suggest how to close these gaps.

2 Scientific Background

2.1 AI-related Competencies and Competence Fields

The International Organization for Standardization defines competencies as “the ability to apply knowledge and skills to achieve intended results” (ISO, 2015, p. 27). In addition to this broad definition, we follow Vuorikari et al. (2022, p. 3) in defining

competencies as “a combination of knowledge, skills, and attitudes, in other words, they are composed of concepts and facts (i.e., knowledge), descriptions of skills (e.g., the ability to carry out processes), and attitudes (e.g., a disposition, a mindset to act)”. Knowledge is developed through the assimilation of information in learning processes and represents “the body of facts, principles, theories and practices that is related to a field of work or study” (ibid.). Skills are described as “the ability to apply knowledge and use know-how to complete tasks and solve problems and can be clustered in cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments) skills” (ibid.). Finally, attitude is essentially the motivator of continued competent performance and is affected by an individual’s “values, aspirations and priorities” (ibid.).

We follow Ferrari (2012) in defining AI-related competencies as a combination of knowledge, skills and attitudes that are required when AI is used or is to be used in the future in companies to perform tasks and as part of their own business model or innovate business models. Additionally, we define competence fields as a combination of competencies in a specific application area. Therefore, synonyms could be competence dimension or competence area.

2.2 DigComp 2.2

The Digital Competence Framework for Citizens 2.2. (DigComp 2.2) is the central digital competence model in the European Union and facilitates a mutual understanding of digital competence, thus creating a framework for developing education programs for digital competences (Vuorikari et al., 2022). DigComp consists of five competence areas, namely information and data literacy, communication and collaboration, digital content creation, safety and problem solving. The five competence areas are composed of 21 competence areas highlighting knowledge, skills and attitudes required for AI (Vuorikari et al., 2022).

3 Methodology

To answer our research questions, we followed a comprehensive research agenda. First, to identify relevant AI-related competencies for business students (i.e., demand analysis), we conducted a literature review and qualitative study. Second, we leveraged a quantitative approach to map which educational opportunities are currently offered in the marked comparing offers from different universities and online platforms (i.e., market analysis).

3.1 Qualitative Study to Identify Demanded AI-related Competencies

Through comparative discussion and differentiation of DigComp 2.2 from other competence models (i.e., Blumberg and Kauffeld, 2021, Dörr et al., 2021, Franken et al., 2022, Teuber et al., 2022, Vuorikari et al., 2022) identified through a comprehensive

literature review, we identify five AI-specific competence areas, which provide the basis for our qualitative study.

1. *Basic Knowledge and Skills:* General technological and mathematical competencies on a higher education level. This includes basic knowledge of machine learning functions and AI design, basic programming skills and data literacy.
2. *AI Innovation:* Entrepreneurship or business development competencies to leverage the opportunities of AI-based technologies.
3. *AI Transformation (strategic):* Competencies that allow managers to transform organisations into data-centric organisations with *data-first* approaches to process development.
4. *AI Management (operational):* In contrast to AI transformation, the competence "AI management" contains the development of management practices for AI applications in organisations (including internal processes such as data management).
5. *AI Implications:* Evaluation of AI-based products and services, but also processes and business models from different perspectives by considering perspectives of all relevant stakeholders:
   - *Ethical* (e.g., following ethical actions): ethical aspects of AI are often context-related (e.g., picture recognition vs. face recognition). Additionally, ethics will be decisive for AI market value.
   - *Ecological* (e.g., greenhouse gas emissions, green IT)
   - *Social* (e.g., working conditions, change of social behaviour, health management)

In a next step, we put the findings obtained through our literature review to the practical test. By conducting 14 qualitative, semi-structured interviews with expert practitioners, we increased our understanding of which competencies are in demand regarding the use and handling of AI systems in practice and where previous deficits regarding employees and their training are to be located. We defined the profile of fitting interviewees for our research aim as follows: Experts from practice who manage interdisciplinary AI projects and/or have an overview of required competencies in such teams. Alternatively, employees of organisations that sell AI products or business angels who invest in AI business models as they have a great overview of the AI knowledge status quo. We approached experts from industries that most commonly leverage AI technologies and/or are disrupted by AI technology (Dwivedi et al., 2021) and that are popular employers for business students; this was based on analysing alumni surveys. 14 practitioners from seven different industries and in different positions agreed to an interview. All interviewees work in business organisations, consulting firms or trade unions and hold various positions with in-depth insights into (1) digital transformation, particularly with a focus on AI and its use, and (2) the requirements regarding AI competencies for (new) employees. These include experts in IT departments, project management or data analytics. Most experts were male (13 male; 1 female). Interviews were conducted online via Zoom and lasted about 60 minutes on average. The interview guide was based on our research questions and contained main questions as well as follow-up questions (DiCicco-Bloom and Crabtree, 2006). After the interviewer provided information about data anonymity, the interview

started with warm-up questions (e.g., about interviewees' position in their company) (Holstein and Gubrium, 2020). Then four questions were discussed to identify important AI-related competencies for business graduates (e.g., what are the biggest challenges in AI-based projects in interdisciplinary teams in which business graduates are represented or are led by them? Which competence gaps lead to problems?). In a last part, we presented the practitioners with our preliminarily identified AI-competencies (i.e., Technological Basics, AI Innovation, AI Transformation, AI Management, AI Implications) and asked them if they found them relevant in practice and if so to what extent. Finally, we asked participants if any aspect was missing in our model.

All interviews were transcribed related to a priori defined transcription rules before being analysed based on an inductive, thematic template analysis (King, 2004) using MAXQDA. Our literature-based initial competencies served as a priori codes. We leveraged hierarchical coding by using the competencies as higher-order codes (e.g., AI Innovation) and underlying aspects as lower-order codes (e.g., "Evaluating market value of AI-business models"). This effort led to five initial higher-order categories; in the process of analysing the data, we also allowed to add codes to the initial template that did not fit the initial codes (ibid.) to further expand our competence model. After the first round of coding, the research team discussed their coding and adapted the template; any inconsistencies were resolved by consensus. Finally, all material was coded again by a different member of the research team (Rust and Cooil, 1994).

3.2 Quantitative Study to Identify Educational Offers to Obtain AI-related Competencies

To answer our second research question and to assess which educational opportunities are currently offered in the field of AI, we conducted a two-fold analysis. To gather a valid, representative, and complementary sample of courses, we first chose to include the curricula of the top 8 AI universities worldwide according to the Times Higher Education World University Rankings (in the following THE-ranking): Oxford University, California Institute of Technology, Harvard University, Stanford University, Technical University of Munich, Ludwig-Maximilians University Munich, Humboldt University Berlin, University of Tübingen. The THE ranking is particularly well-suited as a benchmark, as it is used and followed worldwide (Times-Higher-Education, 2022). Moreover, with nearly one-third of criteria included in the evaluation, it has a strong focus on "teaching" in the evaluation of universities (Ross, 2017). In addition, four selected German universities were considered to ensure the regional perspective regarding offered AI competencies and to derive actionable implications for the German higher education landscape (i.e., University of Bayreuth, University of Hohenheim, Karlsruhe Institute of Technology and Frankfurt University of Applied Sciences). The two-fold analysis enables the comparison between national and international offers. For the selection of online learning platforms whose online courses we analysed, we were guided by the largest and most widely used platforms namely edX, Udemy and Coursera (Cooke, 2022).

To determine relevant AI-specific modules, a systematic search was conducted using the following search string: “AI” OR “Artificial Intelligence” OR “DL” OR “Deep Learning” OR “ML” OR “Machine Learning” OR “Data Science” OR “* Mining”. This search string was applied to various module catalogues of various study programs. Furthermore, a list of associated institute homepages of universities was searched to derive further AI-relevant modules. To analyse the data of the university search, the module name, the corresponding module description, learning goals, the type of course (i.e., lecture, tutorial, seminar), the participating study programs and the intended degree were documented. In the case of the online platforms, the platform name, the learning objectives, the target group, a brief description of the specified course, the title of the course, the costs and further information about the required prior knowledge were recorded.

We analysed the results obtained in each search in detail and categorised the collected data. The categories were based on the results of our qualitative study which revealed four main competence fields that mark necessary AI-related competencies for business students (i.e., basic knowledge and skills with relation to AI, AI Innovation, AI Management & Transformation, AI Reflection).

4 Results

4.1 AI Competencies Model

The results presented in this chapter derive from combining the competence fields based on our literature review with the empirical data from the interviews (study 1). A visualisation of the resulting competence model is depicted in Figure 1.

First, as a foundation, higher mathematics/statistics competencies are necessary for any kind of intervention in AI-related projects. Those consist of *basic knowledge and skills* of machine learning functions and AI design, as well as basic programming skills and data literacy.

Second, *AI Innovation* describes the identification, evaluation, and design of AI-based products, services, processes or business models within and outside of the organisation. As such managers understand what added value AI brings to the organisation and what problems it solves. Hence, use case identification is important. An interviewee brings up the following example: *“For example, cloud applications, what do they mean economically? The business side has to be evaluated.”* (Interviewee 4).

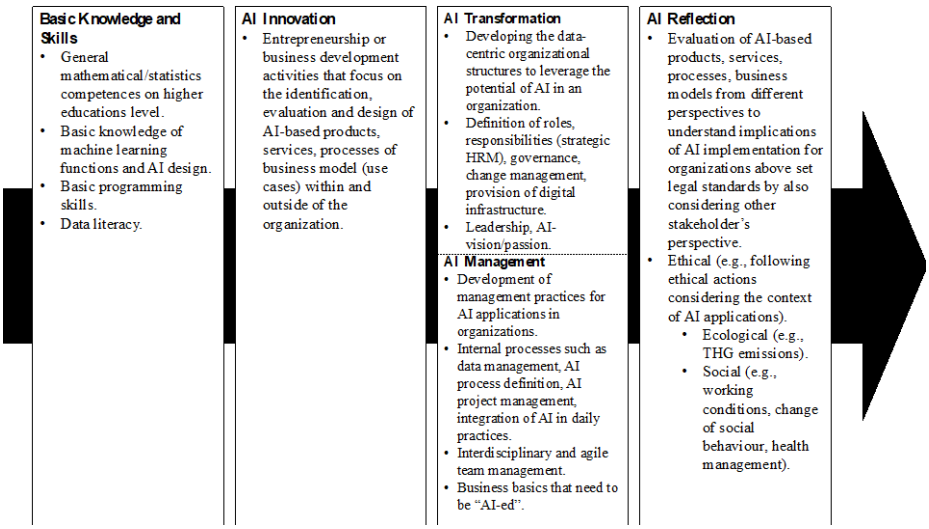

Figure 1. AI Competencies Model

Third, we define the competence field of *AI Transformation* as developing the data-centric organisational structures to leverage the potential of AI in a (data-driven) organisation. This includes defining roles and responsibilities as well as installing change management and provide digital infrastructures. As an interviewee explains: *"Transformation management is an absolute core requirement. Business model development is also part of it for me, being able to build the organisational structure behind it."* (Interviewee 4).

Hence, the competence field also includes leadership with AI vision and AI passion. If the organisation doesn't grow with its digital strategies, it cannot change successfully because the whole team has to be taken into account and responsibilities must be allocated in order to support the product development. This cannot be limited to a small section of the organisation or making single tasks easier, but entire processes across departments.

Next, *AI Management* is defined as developing management practices for AI applications in organisations, e.g., internal processes such as data management, AI process definition, AI project management, integration of AI into daily practice, interdisciplinary and agile team management. These competencies are needed when AI is already in use and operational activities need to be organized and managed. The competencies are based on standard business competencies but need to be "AI-ed" for AI-related projects. One interviewee explains the implication: *"With AI, a lot of disciplines have to work together. You have to have the ability for change processes, new thinking and innovation – in other words, creative technology, which probably also interests many people in economics."* (Interviewee 3).

AI-technologies need special, interdisciplinary expertise due to their complexity and also, they have the potential to change work environments completely (Kagermann, 2015). Therefore, project management of AI projects requires a different set of competencies than non-AI-related projects. Management practices for AI applications need to be installed and with those internal processes such as data management, AI

process definition and the integration of AI in daily practices needs managing. Also, more so than usual, interdisciplinary teams need to be formed and managed.

Finally, we define the competence filed of *AI Reflection* as the knowledge, skills and abilities to evaluate AI-based products/services/processes/business models from different perspectives to understand implications of AI implementation for organisations above set legal standards also considering other stakeholder's perspectives. For example, ethical aspects are always context related. Image recognition and classifying a defect in semiconductor manufacturing, is straightforward in terms of ethics. However, face recognition on the street is more ethically complex. The two examples can consist of the same algorithm. Subsequently, ethics will decide over the market value of AI applications, as one interviewee puts it: *"If one designs a product in order to sell it, then there must be certain aspects considered: convenience, design, a certain elegance and so on. And in the future, when, for example, robots that move autonomously, AI controlled, then it absolutely needs to build in moral approaches and we do well to build in ethical stakes as well."* (Interviewee 7).

4.2 Existing AI Teaching Offers

75 relevant courses from the selected German universities, 154 relevant courses from top universities accroding to the THE-ranking and 130 relevant courses on online learning platforms were the result of our market analysis (study 2). As shown in Figure 2, the courses are divided into four categories: Basic knowledge and skills, AI Innovation, AI Management and Transformation, and ethical, social and legal implications as part of AI Reflection.

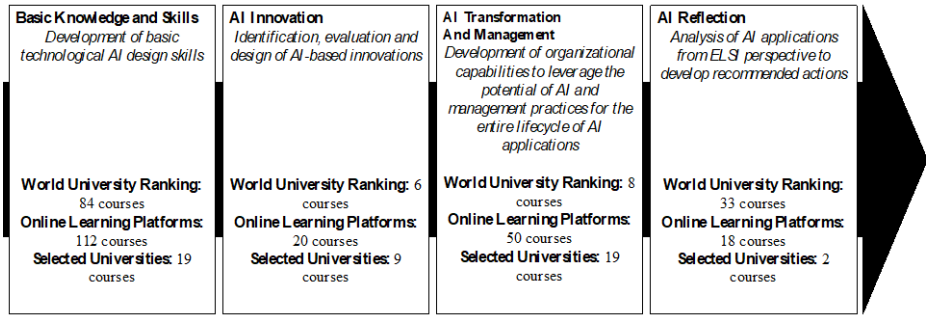

Figure 2. Competence Categories of Relevant AI Courses

The pie charts in Figure 3 present the internal ratio of the four competence categories of the three course sources.

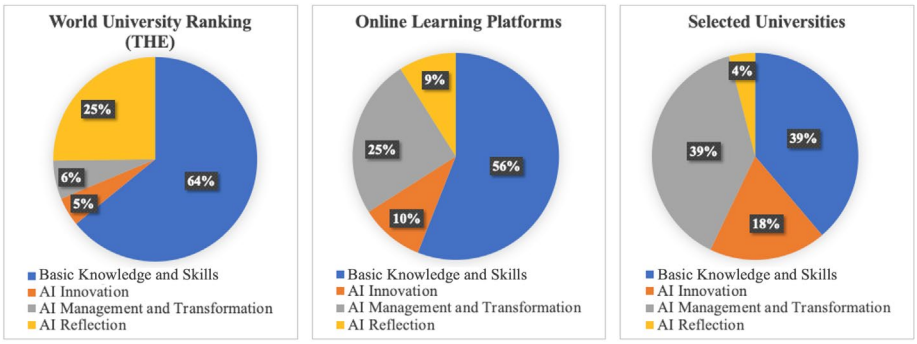

Figure 3. Distribution of the Relevant Courses Among the Four Competence Categories

It shows that the competence group of Basic Knowledge and Skills represent the clear majority of competencies across all three sources, especially for the top universities from the world university ranking (with 64%) as well as for the online learning platforms (with 56%). They also take a primary role regarding the selected German universities (with 39%). Nevertheless, the share of competencies from AI Management and AI Transformation is just as big as the Basic Knowledge and Skills in the case of selected German universities. This shows that AI Management and AI Transformation topics might have a special importance at participating universities. A similar observation could be made for the online learning platforms. 25% of the competencies from considered online learning platforms could be assigned to the AI Management and Transformation category. This finding shows that online learning platforms also offer competencies on AI Management and Transformation in addition to a significant proportion of Basic Knowledge and Skills. A further focus on the competencies derived from the THE-ranking list shows a different picture. Here, competencies assigned to the AI Reflection category follow the Basic Knowledge and Skills with a share of 25%. However, the pie charts reflect that this is the only exception. AI Reflection competencies only appear in the minority by taking the participating universities and online learning platforms into consideration (see Figure 3). Finally, the area of AI Innovation shows a relatively clear picture for the competencies derived from the THE ranking list and the online learning platforms. While competencies from AI Innovation are at least represented in the THE rankings (with only 5%), only 10% of the competencies can be assigned to this category in the online learning platforms.

5 Discussion

To answer our research questions, we conducted a qualitative and quantitative study. First, through a qualitative study paired with a literature review, we identify five overarching AI competence fields (i.e., basic AI knowledge and skills, AI Innovation, AI Management, AI Transformation, AI Reflection) which we organize in one, integrative framework (see Figure 1). While we use DigComp 2.2 as a general basis for

our model, our competence fields differ from DigComp 2.2 in specifically identifying AI competenices for business graduates and members of business organisations whereas DigComp 2.2 focuses on competencies for citizens. By analysing the qualitative data, we enriched our definitions with insights from the field. For example, practitioners made us aware of the importance of a clear vision and priority management of data driven/AI-based solutions throughout value generation. Managers need to drive AI-based initiative, show vision and passion for the topic, otherwise AI-projects easily are being neglected after a while. The practitioners argue that in daily business AI-initiatives often are put on top of regular tasks which, as of now, are smoothly done with older technological solutions. Employees might need to be convinced of the merit of AI-based solutions for their jobs and the importance needs to be made clear regularly to reach the full potential of AI-initiatives. This is not only true for the start of an AI initiative but also after implementation when input data and prediction models need to be maintained (Reim et al., 2020).

Moreover, our results reveal that practitioners mostly seem to look for candidates with a business background who bring basic AI competencies in all fields. Rather than having more in-depth experience in e.g., one particular programming language, practitioners seem to look for candidates who have a clear (basic) understanding of the mechanism of AI-based technology and the possibility of value creation using AI, what prerequisites are necessary and what implications AI implementation has for employees, customers, the organisation, and society at large. Hence, competencies such as AI Innovation, Transformation, and Reflection are important from a business point of view to design technologies in a sustainable way both ethically and economically.
Second, the results of the market analysis show a clear picture regarding the share of Basic Knowledge and Skills through all three educational sources. This current focus might be due to the fact that the technical implementation, feasibility and creation of a fundamental understanding are of great relevance for emerging fields of technology and represents a first precondition for being able to understand the subject area of AI at all. The acquisition of Basic Knowledge and Skills enables the expansion of the methodological learning box, especially regarding the processing of large data sets (Iafrate, 2018). Universities as well as online learning platforms seem to see this trend of exponential data growth and try to educate students concerning the analysis possibilities. In this way, students can be attracted by broad technology and methodology teaching.

Our results also show that AI Reflection competencies are less represented among the participating universities and online learning platforms. In contrast, the top universities seem to be aware of the increasing relevance of ELSI competencies. This observation could be interpreted as a need for such competencies and indicate a new trend for online learning platforms and selected German universities.

Taking a closer look at the competencies AI Management and Transformation, we cannot identify a clear focus on these competencies of any of the three educational resources. While these competencies are underrepresented at the top universities, the online learning platforms and the selected German universities seem to have recognized an initial need. A similar finding can be observed for AI Innovations. Nevertheless, an inter-relational comparison suggests that especially AI Innovation and AI Management do not constitute the core construct of offerings in the case of the top universities. This could be since the fundamental understanding and application of AI may already

represent significant hurdles for business students. Hence, fundamental resources might be required for this issue which could justify the current focus we find.

A fully fledged education for business students in the field of AI does not exist now. Thus, students as future and central decision-makers are only marginally prepared for new, complex questions and changed fields of activity surrounding the spread of AI. In particular, the starting position at universities regarding existing AI courses for business students is limited at the present time.

6 Limitations

We acknowledge some limitations of our work which open opportunities for future research. It should be noted that both studies are subject to a regional bias. The market analysis considers regional though internationally operating, companies and investigated universities in the market analysis represent only German universities. By including more institutions of higher education, this bias could be mitigated to a certain extent. Furthermore, it should be noted that the derived implications cannot be generalised for all types of degree programmes, since e.g., only those courses were taken into account in the market analysis which may be selected by business students. Another limitation is the assumption that AI-specific competencies can be taught exclusively through teaching. It might well be those certain parts of e.g., the AI Management competence area can mostly be acquired via working experience. This emphasises that establishments build on university competencies and expand them with additional knowledge. Existing competence models do help to divide existing competencies into competence groups. However, the practical feasibility shows that just the distinction between AI Management and AI Transformation does not always lead to a clear categorisation in both the demand and market analysis. The definition of further differentiation criteria is necessary here. On the other hand, the competence group on technological competencies enables simple categorisation decisions to be made. This category includes a broad set of methodological approaches. These should be differentiated especially for business students as they do not need to have internalized all types of technological variations. In summary, the fusion of both studies offers valuable insights for this research paper. However, no recommendations regarding the module content can be derived at the current stage as the categorisation was performed at the aggregation level of the competence fields. Further analytical milestones are conceivable within the scope of future research potentially by using descriptive content analysis methods that do not only screen the module descriptions but the whole lecture content.

7 Summary and Conclusion

Our research introduces an integrated AI competencies model for business graduates and provides an overview where to acquire such competencies in institutions of higher education. In terms of our first research question, i.e., what relevant AI-related competencies for business students are, we can state that AI-related management skills

seem to be of great importance for companies in addition to the basic AI-related knowledge and skills. Equally, an understanding of transformation and innovation processes seems crucial. Finally, we identify a great need for reflective skills. For business graduates who want to manage AI projects in the future, it is necessary to learn to assess the economic, ethical, social, and ecological consequences and side effects of technology. The second research question which investigates to what extent universities meet the current demands of AI-related competencies shows that there is a shortage of non-technical seminars on AI at German universities. In contrast, our results reveal a greater offer of the THE-ranked universities and we conclude that the selected universities still need to make this development. The online platforms also have a strong offering of transformational, management and reflective content. The results of the demand and supply analysis combined reveal two main overarching implications:

First, both studies show that basic knowledge and skills are important, but the supply side seems to be overly focussed on this competence. This might be since without a basic understanding of AI technologies neither AI Innovations nor management or transformation can be investigated in detail. Another reason for the clear existence of courses in Basic Knowledge and Skills could be the generic application potential of AI technologies. Still, universities could consider focussing more on empowering business students to in depth reflection of AI technology and focus more on the AI Management and Transformation education. Since these competence fields represent a central perspective on elementary AI problems and are highly relevant for a holistic understanding of AI knowledge (Haefner et al., 2021). Our results emphasize this observation via the rising share of AI Innovation and AI Management with Transformation competencies in the offerings from online learning platforms and selected German universities. While Basic Knowledge and Skills are important, universities could consider collaborating with online suppliers and offering different online classes to students to acquire these necessary technological skills. For example, higher education organisations should consider licensing certain online suppliers and include them in their curricula.

Second, we identify a demand for or the derivation of ethical-social implications of AI technologies (i.e., AI Reflection). Indeed, the importance of critical reflections on AI use and evaluating the application potential of AI from a socio-ethical point of view is considered to be a highly relevant area of research. Consequently, in addition to pure feasibility studies of AI algorithms, the human-machine interaction and collaboration with AI systems is being investigated more and more (Shneiderman, 2020, Wang et al., 2019). At the same time, we find a clear shortage of teaching in this particular competence field among the selected German universities and online platforms. Online suppliers might not teach AI Reflection related competencies well due to their business model. Asynchronous teaching does not foster in depth discussion between participants and tacit knowledge cannot be developed (Pappas, n.d.). The top tier universities, however, seem to have already identified this trend.

In summary, to design relevant and more structured AI curricula at universities and higher education in general, our insights can be used to improve the weak points in the curricula. This can also succeed through cross-university teaching, for example, if economic, social science, and technical universities join forces.

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