



Foundations for the Development of an AI-based, Platformindependent cOmppanion-app [for] Lifelong Learning-Optimization (APOLLO)

Dominik B.O. Boesl¹(✉) , Teresa Achtenberg² and Lisa Bergler¹

¹ Hochschule der Bayerischen Wirtschaft (HDBW) gGmbH, Konrad-Zuse-Platz 8,
81829 München, Deutschland
{dominik.boesl,lisa.bergler}@hdbw-hochschule.de
<https://project-apollo.de/>

² Innomancer GmbH, Olympiastr. 6a, 86179 Augsburg, Deutschland
teresa.achtenberg@innomancer.com

Abstract. In today's knowledge society, the necessity for lifelong learning can be taken for granted. Hence, everybody will be facing the challenge of managing, organizing an optimizing the individual lifelong learning journey. Apart from teaching the essential methodological skills and abilities to enable lifelong acquisition of knowledge and skills, more and more guidance is needed to get an overview of the overabundance of learning content from diverse suppliers.

This paper elaborates on the the basic assumptions, analyses, and framework conditions for the development of an “AI-based, Platformindependent cOmppanion-app [for] Lifelong Learning-Optimization” (acronym: APOLLO) as part of a 36-month funded project with kind financial support from the German Federal Ministry of Education and Training (BMBF) under coordination by the German Federal Institute for Vocational Education and Training (BIBB) as part of the innovation framework program “INVITE”. It outlines the project idea, describes the motivation and problem definition reflected in the educational domain as well as providing an overview of the current national and international state of research. All these aspects have been taken into consideration when defining the functional scope of the application.

Zusammenfassung. In der heutigen Wissensgesellschaft kann die Notwendigkeit zur Befähigung zum lebenslangen Lernen als gegeben angesehen werden. Abgesehen von der Vermittlung der essenziellen methodischen Fähig- und Fertigkeiten, um den lebenslangen Wissens- und Kenntniserwerb zu ermöglichen, ist aber auch immer mehr Lotsenhilfe beim Verschaffen eines Überblicks über das überbordende Angebot an Lerninhalten unterschiedlichster Anbieter nötig. Dieses Paper skizziert die grundlegenden Annahmen, Analysen und Rahmenbedingungen für die Entwicklung einer Ai-basierten, Plattformübergreifenden cOmppanion-app [für] Lebenslange

Lern-Optimierung (Akronym: APOLLO) im Rahmen eines 36-monatigen Förderprojektes mit freundlicher Unterstützung des Bundesministeriums für Bildung und Forschung (BMBF) und unter Betreuung durch das Bundesinstitut für Berufliche Bildung (BIBB) als Teil der Förderrichtlinie des Innovationswettbewerbs INVITE. Es umreißt die Projektidee, schildert die Motivation und Problemstellung im Bildungsbereich sowie den aktuellen nationalen und internationalen Forschungsstand, die zur detaillierten Spezifikation des Funktionsumgangs herangezogen wurde.

Keywords: lifelong learning · AI-assisted learning · skill-assessment · Artificial Intelligence · learning paths · individual learning path recommendation · ESCO · skill profile · taxonomies · recommender systems

1 Brief Description of the Project Idea

The APOLLO app understands itself as a “digital travel companion for the lifelong, individual learning journey”. The goal of the project is therefore to provide people with an AI-based, intelligent assistant that accompanies them on their entire, lifelong education and training path. An individualized, representative skills profile created on the basis of data collected over the long term reflects the personal competencies and development potential of the users and supports them in career planning and development. Lifelong learning thus becomes transparent, plannable and manageable; users are empowered to use their maximum personal potential for professional (personal) development, to consciously plan and actively shape their career path in the medium and long term. This enables them to react early and proactively to changes in their own life situation or unforeseeable socio-economic changes (e.g. digitalization, COVID, ...). Apart from the personal AI assistant to be developed, they will be supported by a variety of services, such as consulting offers or further training suggestions. The human being with his or her individual abilities and skills, hence, returns to the focus of the world of employment, without losing the economic interests of employers out of sight.

A consortium consisting of five partner organizations is working on the development of the cross-platform APOLLO-app (iOS, Androing and possibly a web interface will be supported). The consortium lead by the Hochschule der Bayerischen Wirtschaft (HDBW) consists of the Bildungswerk der Bayerischen Wirtschaft (bbw), the Bildungswerk der Baden-Württembergischen Wirtschaft (BiWe), the TÜV Rheinland Akademie and the Bertelsmann Stiftung. These five organizations are combining their expertise in the educational domain, the data-treasure of hundreds of thousands of data sets as well as the already existing results of other recent (research) projects to create a personalized education guide of the future for everybody’s pocket.

2 Motivation and Problem Definition

Lifelong learning is becoming increasingly important in people's lives. For several decades now, it has been apparent that the required flexibility in everyday working life as well as the ability to reorient and adapt to changing working conditions with newly emerging skill-profiles are becoming increasingly important [1]. This development has been accelerated by the rapid innovations in the field of digitalization [2].

Some researchers even see the (today so common) fixed company affiliation – at least in the segment of top performers – disappearing and predict a shift to cross-company, project-based collaboration in loose organizational or merely contractual structures; permanent employees will work together with hired or leased external experts and other bought workforce to solve problems. In this agile, volatile and short-lived labor market of the future, however, only those who are willing and able to improve themselves further will be able to survive [3]. Only employees constantly acquiring and updating the necessary skills and capabilities for the respective work environment will be able to keep up and succeed [4].

In the area of the so-called 'Individual Contributors (ICCs)' (highly qualified, multi-nationally deployable and globally sought-after top talents), the challenge for those concerned will be limited – in this domain, the competition for the best experts has already flared up and is commonplace. Fueled by the digital transformation, which is bringing about fundamental changes in for many occupational profiles or even their complete substitution, adaptability, flexibility and the will for further development will become important competitive factors on the labor market in the future [2]. In the short term, this trend will propagate throughout the entire qualification pyramid, and thus also in medium- to low-skilled occupational fields. A successfully completed vocational training can and will soon no longer provide a sufficient guarantee to remain employable in the long run, but still represents the necessary basis for an own gainful employment [5]. Therefore, the overriding goal should be to acquire a degree and to keep it up to date. Only those who actively continue their education, adapt to new situations and continuously develop their skill profile will be able to survive on this labor market in the long run [6].

Lifelong learning is the consequence. However, not all employees and job seekers have internalized this necessity, yet. APOLLO provides approaches to address the basic challenges in this context in a timely, efficient and motivating way. The target group is to be sensitized for the necessity of lifelong (further) education, motivated to interact, presented with the appropriate information and individualized content, and the progress moderated and guided accordingly. The employee regains the power to act (instead of reacting) – accompanied by a personal, artificial and intelligent training assistant, the interest of the individual takes center stage and the focus is on securing or optimizing his employability – in accordance with individually set career goals [7]. Based on a lifelong growing skill profile, this assistant accompanies the employee, advises and coaches; manages

and protects personal data; and is a navigation aid in the jungle of Germany-wide further education offers.

2.1 Starting Point: Learning and Adaption are Life Tasks

Even a completed vocational training and what has been learned through it is no longer sufficient to meet the requirements of professional life in the long run. Employability throughout the entire working life can only be achieved if everyone continuously develops his or her competences according to the changing challenges [8]. It should be noted that this personal development is not only explicit (in the form of trainings etc.), but also implicit (during the employment phase, daily and ‘on-the-job’). The understanding of the importance and necessity of lifelong learning must be anchored early in education and, hence, become a fixed, integral part of school curricula. It must be part of the basic educational mission of every school to impart the necessary competencies and skills for continuous, self-motivated further education. This is the only way to ensure that the imbalance on the labor market is not exacerbated by personal aptitude and access to further education (e.g. restricted by social status). Conversely, the comprehensive implementation of appropriate measures can simplify access to education and training and thus actively contribute to a democratization of the labor market.

2.2 Initial Situation: The Educational Market is Very Differentiated

According to the German Institute for Adult Education (Deutsches Institut für Erwachsenenbildung), there are approximately 25,000 continuing education providers. The spectrum ranges from non-profit to commercial, from regional to nationwide and international, from micro enterprises to large institutions [9]. This is accompanied by a considerable variety of types of offers, certificates and degrees as well as different terminology. In principle, this differentiation is a great strength, since it allows a very individual response to different demand situations. However, it must be ensured that this individual need situation and the respective suitable offer also match. There are many regional and supra-regional as well as target-group-specific platforms that are intended to remedy this situation [10]. However, they have not yet succeeded in matching needs and qualification offers to satisfactory extent.

2.3 Target Group Analysis: Barriers to Participation in Continuing Education

In the context of the target group analysis, various personas including their customer journeys were created on the basis of the data provided internally using methods from design thinking. This resulted in various person-specific criteria and characteristics which were taken into account in the target group analysis. In the following, the central aspects of these analyses are briefly presented.

When it comes to increasing participation in continuing education, it is important to consider the individual barriers to participation in continuing education. There are many aspects to this. Examples include, that the person is not aware of a concrete need for further education or that the existing learning concepts offered do not seem to fit. Time constraints due to family and/or work commitments are obstacles as well as offers that are perceived as too expensive and unfulfilled counseling wishes. If, in addition, there is no support (financial or otherwise) from the employer or the employment agency, the person often fails to identify a suitable educational offer.

2.4 Target Group Analysis: Motivation for Participation in Continuing Education

The individual benefit is decisive for the participation in further training. Therefore, the three most important motives are maintenance qualification (further training to maintain the ability to work in one's own field of activity), adaptation qualification (further training to be able to meet changed or changing requirements of one's own work) and promotion qualification (further training to take over other/higher-value tasks) [8]. The aim of the APOLLO project is to encourage the target group to take responsibility for their own employability and professional development and for lifelong learning. Often, the honest and neutral answering of these questions is hampered by a divergence in the self-perception and the perception by others of one's own competencies. A neutral assessment of the users' abilities and skills is – even with the help of selective placement tests or other assessment procedures – usually only very inaccurate and therefore not satisfactory. This is where APOLLO comes in. The companion app suggests suitable training opportunities based on the user's individual skill profile. This AI-based profile, which is generated from a large number of data points, accompanies the person throughout his or her entire lifelong education and thus provides a realistic basis for matching education and job offers with the individual's qualifications.

However, end-users are not the only stakeholders who benefit from a networked, intelligent, AI- and Big Data-driven education solution. Educational institutions can use it to continuously optimize their curricula on the basis of the resulting competency profiles and constant monitoring of learning progress and objectives, and adapt them dynamically and flexibly to the needs of learners as well as companies and supra-regional sponsors (employment agencies, etc.). In addition, the transparent recording of potential demand situations can lead to forward-looking, predictive capacity planning at educational institutions. For companies – regardless of their size – the use of the infrastructure makes sense on several levels: on the one hand, they can offer incentives for those interested in further education to develop into the respective professional field by indicating personnel requirements; possibly, partnerships (similar or the same as the dual study) can even be concluded at an early stage. In the case of applications, neutral, fact-based analyses of the suitability of candidates can be carried out on the basis of their skill profiles and strengths and development potentials can

be identified, which can then be included in a career development plan at an early stage. The skill profiles can also provide a neutral basis for transparent, fair, performance-related remuneration and salary components.

2.5 Methodological Approach and Data Basis

For the development of the APOLLO application solution, a modern, agile, SCRUM-based development process is followed. The development activity is divided into several phases, each of which focuses on one aspect of the APOLLO solution. In line with the agile development philosophy and the design thinking methodology, this phase follows a user-centric paradigm: For APOLLO, the maximization of the user benefit is always predominant. This is illustrated, among other things, by the modeling of a user journey, which – based on a persona analysis – captures the requirements, desires and user processes of the individual stakeholders. From the beginning, close cooperation with the first pilot customers was essential to identify all diverse requirements as early as possible. It is tried to ensure the basic functionality of the application in a conventional, proven way according to the established principles of computer science. In later iterations, smart experimental approaches based on artificial intelligence and machine learning will be successively added.

For the modeling and mapping of the skill profiles, the consortium can rely on the expertise and work of the Bertelsmann Foundation. Therefore, the implementation will be done in close coordination and under consideration of the ESCO framework as well as the ONET skill taxonomies. So far, the mapping of the skill profiles in a graph database is planned. User skills and abilities are also stored in the knowledgebase and enriched with the corresponding ontologies according to the ESCO definition. From the attached architecture and concept visualizations the preliminarily assumed structure and the corresponding data flow can be taken: The user's skill profile is created (as automatically as possible) from different sources (credentials, certificates, self- and third-party assessments, ...). One challenge will certainly be in the recording of non-standardized competencies. (e.g., job references and letters of recommendation in prose), since the contents of these must first be extracted, analyzed, and classified by complex, AI-based methods (e.g., natural language processing). An elementary part of the data structure is therefore the representation of the goals as well as the possibility to categorize the user by his parameters (skill profile, goals, etc.) and to derive, monitor and control his learning journey based on this data. The required data is used to give a weighting to the entities (skills) or nodes. The requirements foresee the validation of credentials and/or certificates via blockchain by the education providers. These also receive a weighting and are reliable data points, especially when comparing and applying analytical procedures from statistics. From the weighted references of the knowledgebase, the digital image (quasi a digital twin) of the user or his competencies, referred to as user knowledge, is created. This represents the core of the user profile.

3 Analysis of the National and Intern. State of Research

The analysis of the national and international state of research leads to a mixed picture. In the business environment, the use of skill profiles has become widespread, especially in larger companies. They are usually used as a proven tool in the context of the annual performance evaluation (also as a basis for the determination of personal goal achievement), for the identification of development potential and as a basis for the transparent description and filling of vacant positions in the company [11]. However, the tools currently in use (e.g., from SAP, Persis, or Evidenz) only rely on manually created and maintained skill profiles, and the assignment of employees to career paths, the monitoring of individual development perspectives, and the implementation of training and development measures are also performed by the respective HR consultant [12]. AI support, the use of big data analytics or process automation is – at best – rudimentarily indicated but by no means widely available. There is also no networking with cross-company or external training offers and platforms. In the educational environment (e.g. at colleges and universities), however, skill profiles are almost unknown, especially in the German-speaking area – apart from the rudimentary use in the allocation of university places for courses of study with restricted admission. Especially in view of the aforementioned widespread use in the professional environment, this is alarming, since the participants in the educational system can neither benefit from the use in the context of personalized education and training nor are they prepared for the use in the company. Nor is there any sensitization about the necessity of or preparation for later lifelong learning [13].

Only in the university domain of (automated) study support / student counselling simple standard questions ('Are you more interested in economics or in natural sciences?') are used in isolated systems, although corresponding solution approaches, e.g. for the automation of first- and second-level support in customer hotlines, have already been tested millions of times. The fact that these problems are often assigned as selective bachelor and master theses, later piloted as rudimentary solutions and not professionally implemented as part of an overall concept, certainly does not contribute to an increase in quality.

Whereas, the necessary basic technologies are available, already tested, robust and suitable for productive use – but there is a lack of definition of an adequate overall package taking into account the requirements and including the necessary interdisciplinary, domain-specific knowledge about the education and training area.

In international comparison, there exist – in the university environment – a manageable number of positive case studies that address some of these aspects: At Georgia Tech University in the USA, students are already successfully supported and taught by 'Jill', a virtual tutor [14]. The quality of the virtual learning environment is so good that students can sometimes no longer tell the difference between it and conventional lecturer support [14]. Genie', a virtual companion at Deakin University in Australia, even goes one step further and offers users interactive help in designing curricula, selecting additional modules and individu-

alized, interest-based scheduling of intra- and extrauniversity activities [15],[16] [17]. Proven, existing approaches from the industrial environment can be transferred to the entire lifelong training path in a goal-oriented and methodologically-didactically sound way. This promises better individual support, transparent insights into and full control over their competence profile as well as the resulting possibility to create personalized learning paths and training roadmaps.

4 Description of Specific App Idea

The aim of the APOLLO project is to accompany people on their education and training path and to support them in the selection of individually tailored training measures as well as in the organization of their lifelong learning. The individual and his or her needs are at the center of our efforts. People interested in further education should be enabled to regain control over their personal development, thereby strengthened in their role as employees and enabled to reflect and develop their personal strengths and interests as fully as possible in a professional profile. It is paramount that the user always has full control and decision-making power over his data and its use. In case of doubt, all interactive components must always act in the sense of data protection and for (instead of against) the user. But a win-win-win situation must also be created for the employing companies as well as for the providers and promoters of vocational and further training. The project is therefore divided into three main components.

The definition and development of individualized skill profiles – AI-supported and with the help of available data (Big-Data) – for the transparent mapping of the abilities and skills of the respective user. They serve, among other things, as a basis for the proposal of suitable further training measures in order to achieve the goals set by the user or as support for the assessment of the personal suitability for the application for advertised jobs. The assistant (which is available to the users e.g. on mobile devices in the form of an app) accompanies the individual on his lifelong educational journey and represents the personification of the user interface. Depending on the preference, the Learning and Skill Companion (LSC) offers a target-group-appropriate approach (among other things with the help of the methods of serious gamification) and helps in the search and selection of further education offers, motivates in the implementation and helps to keep an eye on one's own progress.

The collected data holds great potential for the participating employers, the providers of training and further education as well as the supporting and supporting authorities. Focal points of interest of those interested in further education as well as the needs of the companies can be identified and responded to quickly. Similarly, companies can obtain a better overview of the personnel resources available on the labor market and their skill profiles; based on this, forward-looking personnel planning with corresponding roadmaps can be defined, bottlenecks can be better avoided and, ideally, investments can be made in corresponding personnel development or further training programs and partnerships at an early stage. Both variants represent a decisive added value for the

employer side, because in many cases the companies do not have an adequate overview of the competence distribution of their own employees. Conversely, emerging changes in requirement profiles and job profiles can also be taken into account in the planning of curricula and training contents at an early stage, so that the (further) training managers can also act predictively and with foresight, plan capacities and adapt contents.

5 Conclusion and Outlook

Lifelong learning is a cornerstone of individual and personal development. In an increasingly fast-paced world, where innovation cycles shorten and technological progress sparks disruptive innovations manifesting on Megatrend-scale, humanity is affected globally and on all different levels of society [18]. When technologies like the evolution of mainstream information technology, the Internet, the (industrial) metaverse, robotics, automation, big data and artificial intelligence in all its forms of manifestation start permeating the human living realm, the implicitly affect the workspace. Skill-profiles are altered; new skills are required – sometimes even over night – and affect the whole workforce, often in very unexpected ways [19]. This does not solely apply to technological disruption, though it is usually the fastest, most agile driver of changing skill requirements on the labor market. But also other Megatrends, that affect societies on socio-political, socio-cultural, ethical-moral and socio-economic level, carry these properties. They can act as accelerators as well as inhibitors for societal change [20] [21] – but nevertheless this is what they bring: transformation.

Motivated by these fundamental insights, important interim results have already been achieved within the past 20 months of development, including successful alpha testing as part of the ‘BIBB INVITE Tool Check’. With the help of several development iterations, it was possible to develop a successfully running prototype, which is still being improved and adapted. The basic assumptions presented in this paper can still be regarded as valid, and the various projects within the INVITE project have produced similar interim results. Due to the necessity of lifelong learning, there are still relevant questions for the APOLLO project. Therefore, it is necessary to generate the relevant data with the help of the research project and to put them into context.

However, some challenges still lie in the technical depth: The definition of suitable, accurate skill profiles is not only a concern of the consortium publishing here. The disruptive developments in the field of AI algorithms in recent weeks and months – especially in the area of transformer-based language models and the associated analysis and generation capabilities in natural language interactions – shed new light on the technological core of proposal generation. These aspects are the subject of ongoing, continued research in the consortium and will be addressed within further publications and papers.

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