Demystification of Artificial Intelligence in Education

How much AI is really in the Educational Technology?

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Abstract—The data-driven development of education through Learning Analytics in combination with Artificial Intelligence is an emerging field in the education sector. In the field of Artificial Intelligence in Education, numerous studies and research have been carried out over the past 60 years, and since then drastic changes have taken place. In the first part of this paper we present a brief overview of the current status of Learning Analytics and Artificial Intelligence in education. In order to develop a better understanding of the relationship between Learning Analytics and Artificial Intelligence in education, we outline the relationship between the two phenomena. The results show that the previous studies only vaguely distinguish between them: the terms are often used synonymously. In the second part of the paper we focus on the question why the European market currently has hardly any real applications for Artificial Intelligence in education. The research is based on a meta-investigation of data-driven business models, in particular the so-called Educational Technology providers. The core of the analysis is the question of how data-driven these companies really are, how much Learning Analytics and Artificial Intelligence is applied and whether there is a causal connection between the growth of the Educational Technology market and the application relevance of Artificial Intelligence in Education. In the scientific and public discourse, we can observe a distortion between the theoretical-conjunctive understanding of the application of Artificial Intelligence in Education and the current practical relevance.

Keywords—Learning Analytics, Artificial Intelligence, Education, Data-Driven Business Models, Educational Technology

1 Introduction

After attending several congresses and debates on Learning Analytics (LA) and Artificial Intelligence in education (AIED), we are still wondering where these promising phenomena actually are. Ifenthaler and Yau [1] addressed the further questions of how ready educational institutions are for the implementation of LA and what prerequisites are necessary for a successful application. Luckin et al. [2] see the first challenge in answering these and similar questions in the fact that the discourse on AI is

difficult to follow respectively already in the definition of AI per se. The authors cite as one reason for the lack of understanding or the growing lack of transparency the fact that what the AI contains is constantly changing. Analogously, Bostrom explains: "[a] lot of cutting edge AI has filtered into general applications, often without being called AI because once something becomes useful enough and common enough it is not labeled AI anymore." [3]. Another reason for the difficulty in understanding AI is the interdisciplinary nature of the field per se. The term AI is thus coined by numerous disciplines and constantly changed by new perspectives and terminologies [2,4]. Furthermore, we consider it difficult that, especially in the education sector, applications are often regarded as AI-based at first glance and that the term AIED is often used too undifferentiated. However, the increasing dynamics in the public and scientific discourse on AIED promises a sustainable change in education and knowledge transfer. Thus, the learning path can be personalized, more flexible, more integrative and more committed [2, 5]. For teachers and learners, it can be a monitor to react not only to what they have learned, but also to how it is learned and how the student feels [2, 6].

While the question of the definitory determination of AIED can be answered relatively simple by taking a closer look at the current literature, a number of other questions remain unanswered: How does the AI get into educational institutions? What are the fundamentals that need to be established in order for AIED to be truly suitable for the broad population? What is the relationship between buzzwords such as Big Data, LA or Data Mining, which repeatedly appear in connection with AI, and AIED? Will AIED really fulfill the utopia of a complete individualization of each student or will it finally become a dystopia like Georg Orwell's novel Nineteen Eighty-Four [7].

In order to start at least partially answering some of the questions presented here, the aim of our contribution is to outline the current discourse on the use of algorithm- and AI-based elements in education and to capture the current application relevance of AIED. While the dynamics of AIED are increasing in both public and scientific discourse, it is often forgotten to consider practical aspects. AIED often only takes on a subjunctive character at conferences and exhibitions as well as in discussion groups and contributions, on the other hand we hardly find practical applications.

Our paper is structured as follows: In the first part we briefly outline current literature on LA and AI in education. Then we will look at the relationship between LA and AI. Subsequently, we show current application examples that have already implemented AI in the field of education and actively use it. In the second part, we focus on data-based business models, especially Educational Technology (EdTech) companies that innovate the education market with their products and services. Using data-based business models, we want to create access to the current market dynamics in order to find out how data-driven these EdTech companies really are, how much LA and AI is applied and whether there is a causal connection between the growth of the EdTech market and the application relevance of AIED. In the last part, we briefly summarize our results.

2   Literature Review

It is often difficult to clearly distinguish LA from AI in the field of education. A major reason for this is that evidence of the actual application and effect of LA or AIED is currently only available in fragments. [1, 21]. As a result, the following literature review summarizes both LA and AI in education in a concentrated form.

LA has become a hot topic in higher education [8], as it is considered to be data-driven support to the educational stakeholders, for the purpose of their growth and development. According to Ifenthaler [1], he defines LA as "the use of static and dynamic information about learners and learning environments, assessing, eliciting and analyzing it, for real-time modeling, prediction and optimization of learning processes, learning environments, as well as educational decision-making. They are essential data-driven tools, which allow educators to view the learning progress of students so that they can be supported if they are underachieving or at risk. LA can also be used to motivate students to stay on their university courses and therefore facilitate and increase study success after performing studies on German first-year students to analyze student's perception towards academic competencies [9].

The most common definition of LA is the measurement, collection, analysis, and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs [10], as defined back in 2011 for the first International Learning Analytics and Knowledge Conference (LAK). Boyer / Bonnin [11] claims that LA is also seen as "the process of developing actionable insights through problem definition and the application of statistical models and analysis against existing and/ or simulated future data, [allowing] institutions to experiment with data to gain insight, to improve the student learning experience and student outcomes, and identify improvements in efficiencies and effectiveness of provision.". As we will show in the next part, LA is only one promising component of AI in education. The next step is the implementation of algorithm- or AI-based solutions in the field of education.

The term AI was invented more than 60 years ago. One of the first and most important definitions of AI goes back to the year 1956 by John McCarthy: "The study [of artificial intelligence] is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it" [4, 12]. Over the years, various discipline-dependent definitions of the term AI have developed in e.g. chemistry, linguistics, mathematics and, more recently, in teaching and learning in higher education. Research works on AIED dates back to early 1970s, started by a group of AI researchers, as the motivation to understand the profound association between Education and AI, with its main concerns on knowledge representation, reasoning and learning [13]. From then on, several international conferences (notably AIED conference), committees, proceedings, social events were significantly growing. In the current scenario, [14] the greatest contributors in this area are the International Journal of Artificial Intelligence (IJAIED), Computer and Education, and the International Journal of Emerging Technologies in Learning. A large number of platforms are available but the major contributions for AIED come from the above-mentioned Journals. One

of the most common definitions of AIED was formulated by Popenici/Kerr [4]. The authors define AI in the context of education "as computing systems that are able to engage in human-line processes such as learning, adapting, synthesizing, self-correction and the use of data for complex processing tasks". Luckin et al. understand AIED as an interdisciplinary field of research, whereby the interdisciplinary character is located on several levels [2]. AI is to be understood per se as an interdisciplinary phenomenon and is complemented by learning sciences (pedagogy, psychology, neuroscience, linguistics, sociology and anthropology). The aim is to develop adaptive, integrative, flexible, personal and effective learning environments that complement classical/traditional education and training formats. Recent publications on AIED increasingly focus on questions such as what AIED actually means, what we can expect from the use of AIED, and where there are currently limits to the use of AIED [6].

The evolution of different theories and models from a number of theoretical and descriptive studies that was conducted during the late 1980's, has led to the recent shift towards the usage of AI applications such as Learning Management Systems (Moodle), Intelligent Tutoring Systems (ITS) for providing constant feedback to the students, Assessment systems for evaluating the student's performance, Educational robots for providing the student's with personalized learning tailoring the educational contents according to the student's unique needs [15].

AI contributes to LA by providing different AI applications that supports learning and teaching. The four notable areas of AI applications [14] are a) profiling and prediction, b) intelligent tutoring systems, c) adaptive systems and personalization, d) assessment and evaluation. Each category is narrowed down to a number of sub-categorized AI applications and contributes to support a different learning artefact.

According to the results of the analysis of 252 peer-reviewed papers between the period 2012 and 2018, conducted by Viberg et al. [16], 57% of the research papers follow a descriptive research approach, often associated with experimental studies and interpretative studies. 26% of the research studies emphasize theoretical frameworks, models, and theoretical concepts used and the rest of the papers concentrate on theory generation and philosophy. A similar kind of study on 146 journal articles by Viberg et al. [16] shows that a majority of studies (73.3%) applied quantitative methods. Of all the papers reviewed, a general consensus emphasizes on the evidence of improvising the learning outcomes through learning analytics. Most of the evidence (35%) relates to the proposition, LA improve learning support and teaching, including retention, completion, and progression. Although very little evidence is available when it comes to improving learning outcomes through LA [16]. A study by Ferguson / Clow also provides a piece of strong evidence for the mentioned proposition [17]. AIED also has a good probability to support teaching and teachers by reducing their daily routine tasks [18].

The main challenges that arise, due to AI-based intelligent agents in a learning environment, are privacy concerns due to the dealing of user's private information such as learning styles and learning capabilities [19]. Despite the criticism of ethical, privacy and social concerns due to LA, there is very little evidence (9%) when we reach out for papers on ethical implications [17]. In order to understand the research contri-

bution in different countries, Zawacki-Richter et al. performed a systematic review of articles, conference proceedings and book chapters that were published in international platforms. Results show that 19 countries contribute to the research work in AIED, and only 4 countries namely the USA; China, Taiwan, and Turkey seem to be very active in their contributions. The USA publishes around 43 articles per year and China, Taiwan, Turkey publishes 9-11 articles per year. Until 2018, Germany seems to have a count of 2 publications per year [14]. Although the research on LA is scarce in Germany, the German Federal Ministry of Education and Research has funded several projects in 2019. For example, the STELA project aims to conduct systematic reviews and construct a set of policies for the German Higher educational institutions to adopt the benefits and capabilities of LA [20]. Even though there are a number of attempts to emphasize the usage of LA in Education, there is a constant need due to ethical and privacy implications.

3　　Learning Analytics and Artificial Intelligence in Education

3.1　　Relationship between Learning Analytics and Artificial Intelligence

Holmes et al. note that the future impact of AI is still very unclear [6]. Unaffected by this, more and more efforts and investments are being made in the development and implementation of AI. Information technology penetrates and transforms how we work, study and deal with information and knowledge. As a result of this digitalization, large amounts of data are generated about our behavior. In areas such as the economy or the transport sector, the use of analytics has long been part of our everyday life. With the help of analytics, large amounts of data can be processed to develop data-driven insights into people's activities to optimize processes and outputs [20]. But it is often not clear which things in everyday life are supported by algorithm -or AI-based systems and it is rather difficult for the user to determine when such implementations are present [6].

The challenge of assigning algorithm- or AI-based systems is not only of practical relevance. Even in current research, it is not always obvious when algorithm- or AI-based systems can really be assumed. Basically, AIED, LA and Educational Data Mining (EDM) are the three research communities encompassing the concept of Technology enhanced learning and how to utilize the available digital data to improve the quality of higher education [22].
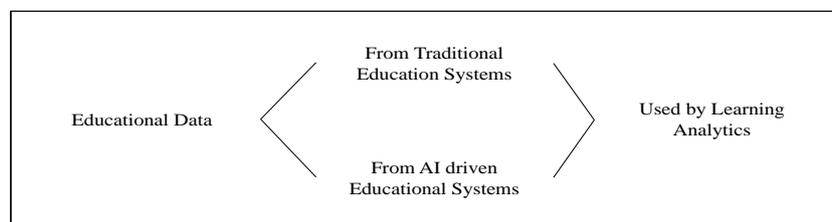

Fig. 1. Picturizing the relationship between AIED and LA

However, the relationship between these three communities should be addressed to understand their respective impact on education. The emergence of new concepts and technologies like Blended Learning and e-Learning [23] has given rise to an enormous amount of data, which can be used by EDM and LA to predict student's learning behavior, progress and potential risks of a student [18].

According to a recent analysis performed by Labarthe et al. [22], all three communities are centered towards 'students', 'learning' and 'usages', with EDM and LA communities imposing its focus on data, whereas AIED does not focus on data. Although, there are few commonalities between EDM, LA and AIED, the main concept that distinguishes it from each other is that, EDM focuses on providing automated decisions and predictions using machine learning algorithms. LA focuses on visualizing the data to give better insights into the student's learning experience and helps to further optimize the learning environment. AIED focuses on providing intelligent agents and tutors through AI facilitated learning platforms [22, 23].

As traditional classrooms being replaced by digital and tech driven classrooms, AI is intervening in today's and future education. The need of highly personalized learning has led us to the usage of AI tools, which is also used to serve and support the educational institutions at every level, from administrators, to teachers and students. AI tools such as student support chatbots (AI driven Personalized Instructional and Dialogue systems), Intelligent Tutoring Systems (AI supported system replacing teacher-student tutoring) and Assessment tools can be potentially used to advance the capabilities of LA [14]. In the foreseeable future, AI in education is going to serve as a supporting component to further enhance LA.

3.2 Practical applications

As can already be seen from the current application areas, algorithm- or AI-based systems in education are often described as intelligent, adaptive or personalized learning systems. An essential feature of these systems is the collection and analysis of large amounts of data about the behavior and habits of learners [24]. Although AI technology has been in the scientific discourse for more than 60 years, practical applications in education have only been advancing for a few years. The big tech lords such as Amazon, Facebook and Google have invested in promising AI systems that will influence and change teaching and learning behavior in the long term [25]. For example, data-based business models such as Knewton, Bettermarks or Carnegie Learning are currently available on the market [26, 27, 28]. These applications are going this path and design and implement algorithm- and AI-based solutions for education and training. Knewton, for example, collects all user data and establishes links between the learning behavior of individual learners. From this, learning types or success prognoses can be derived. In the next step, complex algorithms define individual learning packages based on this database, the content and speed of which are continuously adapted [26]. As a result, software solutions such as Knewton or Bettermarks offer individually designed curricula for everyone. Especially in the USA, more and more universities rely on algorithm-based solutions to support learning success, curricula and the study process per se. Since 2011, Austin Peay State Univer-

sity (APSU) uses a Degree Compass, which generates course recommendations for students according to the Amazon or Netflix logic [29]. In addition, the Compass predicts, among other things, the probability of a course passing. Another example for algorithms-based solutions is the eAdvisor used by Arizona State University [30]. The personalized eAdvisor guides the students through their studies while all user data/behavior is recorded. In addition to the USA, example of the use of AI in higher education can also be found in Australia. The Deakin University in Australia integrates the IBM's supercomputer Watson, who provides 365 days feedback to students and replaces at this moment, the university employees that have done these jobs before [31, 32].

Although the examples listed here have been successfully implemented in the field of higher education, it should be mentioned that they are at the same time only flagship projects in the field of AIED. It remains questionable whether there is a wider range of applications on the market for the successful use of AIED. In order to approach this question, in the following we look at data-based business models, in particular EdTech companies that are considered to be ambassadors for AIED. A look at the current value proposition of EdTech companies should help us to answer the question of how much AI is actually in the services. The basis for this is a study by Hilbig et al. [39], who examined a larger section of the European EdTech market.

4 Data-Driven Business Models in Education

4.1 Data-driven business models

In the course of digitalization, radiational corporate strategies, such as the sale or maintenance of products, are being expanded through the integration of digital services [33]. This gives companies the opportunity to collect, evaluate and interpret customer data and thus provides the basis for a change from business models (BM) to new data-driven business models (DDBM) and thus new market opportunities [34, 35, 36, 37, 38, 39]. When talking about BM, this often goes hand in hand with the aim of making money [40] or that the organization aims to create a value [41]. Abdelkafi defines a BM as "the way a company communicates, creates, delivers, and captures value out of a value proposition." [42].

The framework of DDBM is comparable to other common BM that are consisting of the six dimensions: key resources, key activities, value propositions, customer segment, revenue model/cost structure [35, 43, 44]. A very detailed definition is given by Exner et al. "The data-driven business model needs to fulfil application-oriented requirements and content-related requirements [...] The main part is described as Data-driven value creation and represents the core processes, resources, abilities and partners to enable the individual customer solution. The processes focus on data processes including phases such as data acquisition, data analysis and visualization as it will be needed for the customer solution. The resources add the core products, digital platforms or other technical infrastructure." [45]. Several studies have already proven

the influence and relevance of these data-based business models several times [33, 34].

As the key resource within the DDBM framework is data [43, 43] the innovation of DDBM has led to an increased use of data techniques, however data must be interpreted and analyzed meaningfully and correctly, otherwise they are useless [46]. The next sections illustrate whether EdTech companies are already providing a corresponding AI architecture today.

4.2 Educational Technology (EdTech)

Not only in the field of business but also educational systems are undergoing major digital transformations [1]. In the field of education and the resulting EdTech sector, however, there is so far little study basis to draw conclusions about their influence on the education system [39]. The definition of EdTech is changing, while ten years ago it meant the presence of computers in classrooms, today EdTech refers to a large number of start-ups and other organizations working to revolutionize education and quality through the use of technology [47]. EdTech also describes the digitization of educational services and business models [39]. The Association for Educational Communications and Technology (AECT) defined EdTech as "the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources." [48]. Due to the rapid technological developments and associated innovations, however, it remains difficult to define EdTech [49]. Corbeil and Corbeil even concluded that "attempting to come up with a unified definition of the field was like trying to hit a moving target." [49]. The varying job descriptions of EdTech practitioners as well as their skills, show the wide range of responsibilities and thus the struggle to identify a definition for EdTech (the top five roles included: instructional designer (53.1%); course developer (33.3%); instructional materials developer (32.1%); college/university professor (28.4%); and, consultant (26%) and the top five skills were: instructional design (90.1%); teaching with technology (85.2%); e-learning development (77.78%); technology integration (74.1%); and, training/tutoring (71.6%), [49]. After classifying and defining EdTech in the field of DDBM, we take a closer look at the market development of EdTech services in the next part.

4.3 Market development

Hilbig et al. [39] report that more and more EdTech companies are entering the market with innovative and diverse services in order to change the education sector sustainably. A closer look at the public discourse on mass media in Germany also shows that providers of traditional teaching materials have been preparing for years for the digital revolution in the education sector and converting their products and services to digital solutions. With the development of e-books, digital teaching aids and apps as well as virtual and augmented reality applications and online diagnostic tools, traditional textbook publishing houses have also invested early in the digital future with a multitude of digital solutions. However, the sales figures put the dynam-

ics of the education market into perspective with the ambitions of the providers. The willingness to purchase is currently still very low, so that less than 5% of sales are generated with digital solutions [50]. Analogously, the Global Start-up Ecosystem Report [51] predicts a growth of investments in the education sector by suppliers and consumers. However, it is already predictable that growth in the EdTech sector will increasingly slow down. Correspondingly, the EdTechXGlobal Report [52] predicts that the market will grow much more slowly than other markets in the course of digitization. Co-founder of the EdTechXGlobal Vendrenne-Cloquet describes the market development as "a long rising tide than an avalanche" and digitalization in the education sector is predicted to develop up to five times more slowly than in other sectors. One reason for this is the number of decision-makers - teachers, institutions, politicians, districts, parents, to name a few - who are involved in the process of digital transformation in the education sector.

Hilbig et al. [39] concluded, that data-driven business models in education is still a very young field of research. The authors have analyzed 313 European EdTech companies with a view to their business models. On the one hand, the aim was to find out how data-driven the business models of the EdTech companies actually are and on the other hand to what extent LA and algorithm- or AI-based elements are already implemented in the business models or offered as user services. The results show that the majority of companies specialize in e-learning (44%), followed by mobile learning (12%) and infrastructure (8%). Only two companies explicitly emphasize LA as a service or have anchored it as an integral part of their business model. Building on this, Hilbig et al. [39] conducted semi-structured interviews with 25 of the 313 EdTech companies. The intention of the interviews was to get a deeper understanding of the use of LA and algorithm- or AI-based elements. In addition, the authors want to find out whether and, if so, how the digital data is collected, evaluated and, if necessary, used for the further development of their own business models. It turns out that current business models of EdTech providers are integrating LA within their value propositions on three levels. The results of the interviews were mapped in data paths and levels of LA as follows:
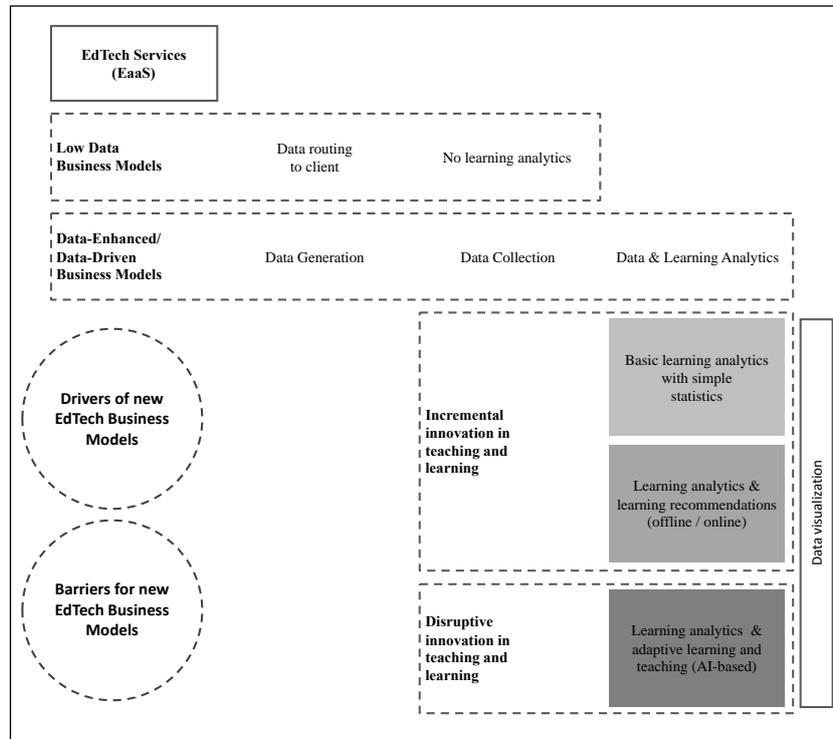
Fig. 2. Data Paths and Levels of LA [39]

Figure two presents two paths of how EdTech companies use data in their business models. The first path delivers the data directly to the client and is not stored, generated or even analyzed by the EdTech company (Data Routing). The generated data of the teaching and learning process is stored on the client's servers and at his responsibility. The second path is determined by the fact that the EdTech provider generates digital teaching and learning data which could be personalized user data or non-personalized user data, depending on the regulations of the client and/or the country they are operating in. This path can now be further differentiated according to the degree of data analysis into three further characteristics. Basic LA, LA and algorithm-based or human-based recommendations and LA and adaptive teaching and learning (AI-based). The characteristics are based on Picciano [53], who has determined the advantages of Big Data and LA using Blended Learning elements. The majority of EdTech companies operate in the Basic LA sector. However, there are hardly any examples on the adaptive teaching and learning level.

With reference to the work of Hilbig et al. [39] we have observed that the digitally induced dynamics cause different processes of change. The technical potential in the EdTech sector already leaves a lot of scope for the design of teaching and learning. These potentials are used by EdTech companies by penetrating the market with a broad spectrum of digital approaches. Especially algorithm- or AI-based solutions have the potential to shape the education market in the long term. According to

Buschbacher [54], such new technologies are always caught between enthusiasm and rejection. Some see them as long-awaited solutions for existing and future challenges, others as a further step towards incapacitation. Both are equally hyperbolic and harmful as they block the view of benefits and side effects. But what causes the discrepancy between what is technically possible and what is actually in demand in the EdTech sector? Although algorithm- or AI-based applications could already be implemented today, we hardly find any evidence and examples in the public and scientific discourse. Hilbig et al. [39] emphasize four essential aspects that influence this new development and application dynamic: the general cultural change, individualization, sustainability and human contact/socialization.

4.4 Current challenges of implementing LA and AI in Education

As we have already outlined, AIED is the measurement and acquisition of digital teaching and learning behavior based on LA, but it's still in its infancy and the potential has not yet been exhausted. The study by Hilbig et al. [39] shows that AI-based teaching and learning solutions are hardly to be found on the European market. Data-based business models, especially in the EdTech industry, often only rely on basic data. The causality follows, increases with the number of EdTech companies on the market, not necessarily the use of AIED. Often the solutions are limited to simple data collection, which does not allow individualization or personalization at all. The market is already failing due to LA applications, as users are unsure about the use of their personal data. The lack of evidence of LA in education finds its way basal into the scientific discourse, but cannot claim a claim to extensive empiricism for itself. Although the outline of current use cases in Section 3.2 suggests a different picture, the promised innovation potential of LA and AI in education is initially constructed on a theoretical-conjunctive level.

This raises the question of which barriers and challenges are associated with a widespread implementation of corresponding AIED. The existing discrepancy between the theoretical discourse, which can currently only be supported by a few flagship projects, and market observation is quite immanent. Hilbig et al. [39] cite general skepticism about data collection and the lack of understanding and sovereignty in dealing with data as the main reasons for the lack of data-driven business models in the EdTech sector. Following the causality, LA and algorithm- or AI-based solutions cannot be developed without a correspondingly extensive data collection, which forms the basis for the derivation of statistical models, the creation of forecasts and thus for optimized and individual learning possibilities. This is supported by the challenges researched by Ferguson et al. in the implementation of LA [55]. Here it becomes obvious that the responsibility for the correctness and timeliness of the data lies partly with the learner himself, whereas the state of the art, the reliability and the validity of the evaluation process must be guaranteed by the provider. There are also reports of restricted freedom of movement when it comes to the release of data in educational institutions [56]. Especially in European countries, this transparency is often regarded as inappropriate control. Access to the data itself and the associated possibility of changing this data plays a further role and can lead to a barrier to the

introduction of LA [57]. A further obstacle to the application of LA could be uncertainties about the General Data Protection Regulation (GDPR), which regulates the protection of personal data and the violation of which can lead to fines of up to 300,000 euros per individual case [58, 59]. In addition, the lack of resources such as technical understanding, the technology itself and its personnel and the general ignorance of technical potential are cited as barriers to the application and development of LA [1,34].

There is still a lack of role models and possibilities for testing LA and thus for advancing its development [1]. So far there is also a lack of evidence related to the advantage of the introduction of LA [1], at least through an investigation of personalized technology-supported out-of-school programs this evidence could be confirmed in the subject's math and languages through high test results as well as an increased productivity through the possibility to teach all students equally effectively [60]. We can observe that the lack of evidence on the use of LA and AIED in public discourse raises the question of whether digital learning opportunities are actually better [61, 62]. This further strengthens the negative attitude of potential users.

5   Summary and Conclusion

In the context of education and training, AI plays an increasingly important role and is one of the currently emerging fields of Ed Tech [14]. Also, the innovation potential for the use of algorithm- and AI-based elements in education already exists. Looking at the market, it is now more important to prepare the demand for the potentials of the actual applications and to dismantle barriers. Following Pedró et al., educators still face challenges when it comes to how they can gain pedagogical advantages and use AI concretely and meaningfully in the learning and teaching process [63]. Considering the fact that the education sector is opening up more and more to digital change, Conde and Hernández-García [64] question how the data generated can be processed appropriately and how representative conclusions can be drawn for students. As a result, users of such digital services increasingly create large amounts of digital footprints in various educational applications and learning management platforms. Dräger and Müller-Eiselt [7] classify education as a particularly sensitive topic. With regard to the storage of learning data, there is a risk that making mistakes, as an important component of the learning process, will lose a secure, protected space through data tracking. Ifenthaler and Yau support this observation in their study [1]. Data protection is one of the biggest challenges associated with the successful implementation of AI-based elements in education. An analogous opinion is shown by the interviews of Hilbig et al. [39]. In addition to the questions about data security and storage, a large number of prerequisites are needed to establish AI in education.

In conclusion, our observations and results from the brief overview of the scientific and public discourse can be summarized as follows:

- The application possibilities and potentials of AIED are often supported by a subjunctive character.

- In addition, there are only a few application examples which are cited repeatedly in current publications.
- The evaluation of the market studies in the EdTech sector shows that there are hardly any AI-based elements in the education sector or that most EdTech applications make use of simple statistics and LA in rudimentary form.
- A causal relationship between market growth in the EdTech area and the use of algorithm- and AI-based elements in education cannot be established.
- The dynamics on the market for the development and implementation of AI-based systems in the education field is clearly slowed down by the restrained/skeptical demand.
- AI requires a corresponding infrastructure: The basis for the development of AIED - data collection, collection and analysis are often assumed, but only a few publications actually explicitly mention AI as a prerequisite.
- Demand is subdued as essential issues of data security and sovereignty as well as ethical issues remain unresolved.

The debate shows how complex the subject is, but it can be said that we are not in the process of a data-driven revolution, rather an evaluation. As the questions raised at the beginning of this paper demonstrate, the research spectrum in the field of AIED is still huge. Follow-up research should more focus on the implementation of AIED from a practical point of view. In this respect, it is interesting to investigate why AIED has already been introduced more successfully in some markets (e.g. the Asian or South and North American Markets), while in Europe in particular the reluctance is still very high.

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