CHAPTER

Educational Data Analytics:Harnessing Big Data for Higher Education Enhancement

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Introduction

Big data is a phenomenon that is driving paradigm shifts in higher education and opening unprecedented possibilities in educational institutions. Big data has transformed data generation and aggregation in education, becoming a tool for educators and administrators to make more effective, data-driven decisions in the last decade. Higher education institutions are using big data analytics to monitor student performance, optimize educational strategies, personalize the student experience, and improve overall institutional effectiveness (van Leeuwen, 2023). Harnessing big data for higher education enhancement offers a unique opportunity to better understand students' educational processes, improve teaching strategies and optimize the overall performance of institutions. Big data applications aim to break traditional boundaries in higher education and lay the foundations for a more efficient, personalized, and student-centered learning environment. This book chapter discusses the scope of the big data revolution in higher education in terms of educational data applications and aims to detail the application areas of educational data in higher education.

Educational Big Data

Data are recognized as a crucial catalyst in facilitating transformation in the current era. Big data are large-scale and complex data sets that cannot be stored, managed,

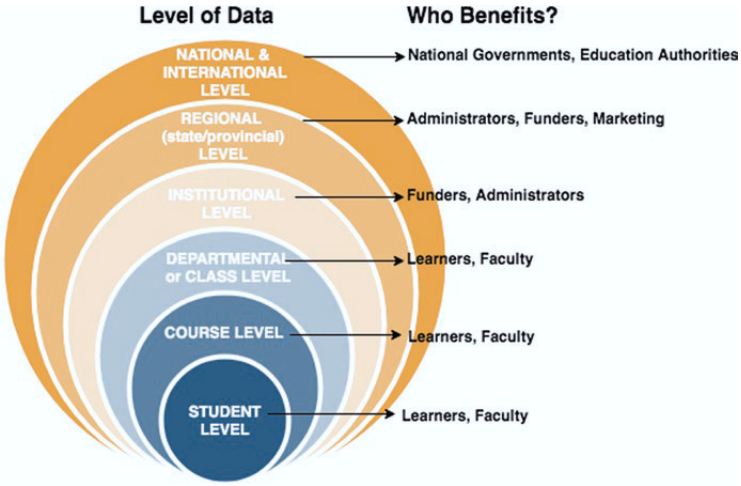
and analyzed with traditional data processing techniques. Big data refers to data that is continuously generated from the internet, social media, mobile devices, sensors, cameras, and other sources and needs to be processed. Big data offers new opportunities, insights and value for businesses, organizations, and individuals. The characteristics of big data are defined as 5Vs: Variety, volume, veracity, velocity, and value (Daniel, 2024). These characteristics can be explained as follows:

- **Variety**: Big data encompasses different types and formats of data, whether structured, semi-structured or unstructured. For example, text, audio, video, image, log, GPS, web, social media, e-mail, survey, sensor data. Data from different sources needs to be transformed and integrated to make this data meaningful and useful.
- **Volume**: Big data refer to very large amounts of data. This large amount, usually on the order of terabytes or petabytes, is constantly increasing. Traditional database systems are insufficient to store, process and analyze this data. As a result, there is an ongoing development of new technologies, algorithms, and platforms specifically tailored for applications in big data.
- **Velocity**: Big data refers to fluid and real-time data that is generated very quickly. For example, social media posts, online shopping transactions, live video streams, sensor data. High-performance systems and techniques are required to collect, process, and analyze this data instantly.
- **Veracity**: Big data refers to data of variable quality, reliability, consistency, and accuracy. For example, social media posts, user comments, survey results, sensor data. To analyze this data accurately, processes are required such as data quality, data cleaning, data integrity, data validation.
- **Value**: Big data refers to potentially high-value data. Big data can provide benefits for businesses, organizations, and individuals in areas such as decision making, strategy development, business intelligence, personalized education, customer satisfaction, productivity increase in industrial sectors, and cost reduction. However, to achieve these benefits, big data needs to be analyzed, interpreted, and applied correctly.

Educational settings have big data from many data sources. Students are generating a substantial amount of data as they engage in their studies in the realm of online education. The characteristics of big data also apply to educational big data. It will be useful to explain the 5V of educational big data in detail. Every day, trillions of educational data have been generated in millions of educational institutions in the worldwide. This represents the *volume* characteristic of educational big data. The accelerated emergence of this data corresponds to the *velocity* characteristic of educational big data.

Educational data sources are differentiated in higher education. As known in the literature, educational data are not generated from a single source. A large number of educational data emerges from more than one source. Educational data encompasses a diverse array of information from various sources, including internal data such as school-wide and classroom-specific information, as well as external data from the specific regions (Mougiakou et al., 2023). Figure 1 summarizes the variation of educational data by level and the beneficiaries of this data.

Figure 1. *Levels of Educational Data in Higher Education (Long & Siemens, 2011)*



In educational institutions, many different types of data are obtained from many data sources such as teachers, students, administrators, and administrative staff. Data emerges from many different contextual settings such as student-student interaction, student-teacher interaction, behaviors observed in the classroom, personal characteristics and performances of students, relationships between teachers. Various forms of data can be collected, encompassing students' emotional states, demographic characteristics, interaction behaviors within the learning management system. This points to the *variety* characteristic of educational big data.

A prerequisite for handling educational big data from so many different sources to ensure the educational big data's *veracity* (Bai, et al., 2021). It is crucial to meticulously choose and implement data sources, collection methods, processing techniques, analysis tools, and interpretation strategies to ensure the precision of educational big data (Li & Jiang, 2021). The *value* of educational big data is a critical aspect to consider. Presently, numerous issues associated with educational big data are being examined, and various scholars are actively engaged in developing applications for educational big data. These applications encompass prediction, recommendation, and evaluation. Specifically, prediction involves forecasting student performance, employment prospects, unemployment rates, and funding availability. Additionally, recommendation focuses on suggesting proper courses, advisors, and job opportunities. Lastly, evaluation concerns the assessment of student academic performance, student emotion, student behavior, teachers' teaching, and research practices (Baiet al., 2021).

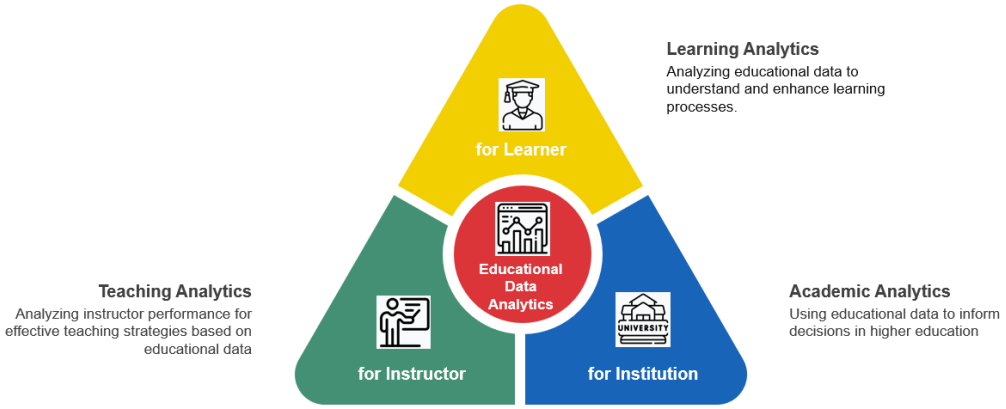
Educational Data Applications in Higher Education

The principles of data-driven decision-making are applicable not only across various sectors but also in education. The volume of educational data related to students, their learning processes, and learning environments has experienced an exponential increase. Educators have the opportunity to leverage the abundance of educational data and the capabilities of data analytics technologies to acquire valuable insights, encouraging creative methods that improve both the learning and teaching processes. Educational data have the capacity to unveil insights pertaining to course design and instructional practices that may otherwise go unnoticed. Moreover, by analyzing educational data, instructors can gain a comprehensive understanding of their students' past, present, and potential future, enabling a profound comprehension of students' activities, behaviors, and preferences. Consequently, educators can skillfully customize their teaching and learning interventions, delivering a personalized learning experience to students,

offering improved feedback, and providing the necessary support for them to attain their educational goals. The advantages of educational data are not limited to students and teachers. It also offers unique opportunities for administrators and policy makers of educational institutions.

Harnessing big data in higher education varies according to the source, purpose, and context of the data. In considering the higher education ecosystem and its components, it can be stated that the utilization of educational data will generate valuable information and recommendations for students, teachers, and universities/institutions. In a holistic view, main application areas and concepts have emerged for the use of educational data in higher education in this context such as learning analytics, teaching analytics, and academic analytics. Figure 2 summarizes these concepts.

Figure 2. *Educational Data Analytics in Higher Education*



This book chapter will provide information about learning analytics and related sub-fields. The focus of the chapter is harnessing big data for higher education enhancement. It will explain how using educational data in higher education can contribute to students, teachers, and the institution. While not the primary focus of this book chapter, it is important to note that addressing *multimodal learning analytics* constitutes a significant endeavor in the context of utilizing big data to enhance higher education.

Learning Analytics in Higher Education

Learning analytics is an interdisciplinary research field that has emerged in the last decade. As a concept, learning analytics can be defined as "*the measurement, collection, analysis, and reporting of data about learners and their contexts, for the purpose of understanding and optimizing learning and the environments in which it occurs*" (Siemens & Baker, 2012). Alternatively, learning analytics can be characterized as the systematic analysis and utilization of both static and dynamic data concerning learners and learning environments. This process aims to model, predict in real time, and enhance learning processes and educational settings (Ifenthaler, 2017). As a literal definition, "*learning analytics is the analytics of learning*". The focus has been on addressing challenges linked to the increasing availability, volume, velocity, and diversity of data within learning environments (Lang et al., 2022). It involves the collection, analysis, and presentation of data from the learning environment with the goal of providing evidence regarding the effects of a particular learning design (Stoyanov & Kirschner, 2023). Learning analytics entails the implementation of interventions grounded in the analysis of learner data, with the conviction that such interventions can have a positive impact on both the learning process and the learning environment. It can be conceptualized as the

analysis and representation of data about learners, with the goal of improving learning and providing teachers with a fresh perspective to better understand and advance education (Herodotou et al., 2020). Moreover, learning analytics has demonstrated notable benefits for education, including heightened student engagement, enhanced learning outcomes, early alert for at-risk students, personalization of learning experiences, and provision of real-time feedback (Banihashem et al., 2018). The incorporation of research in both learning design and learning analytics serves as a crucial contextual overlay, enhancing the understanding of observed student behavior. This integration enables the provision of essential pedagogical recommendations, especially in cases where learning behavior diverges from the intended pedagogical goals (Macfadyen et al., 2020).
Visualizing the data related to the learning process and presenting it instantly to the learners is provided by using the learning analytics tools developed. Learning analytics data are used through dashboards to provide meaningful messages about learning processes to learners, instructors and institutions. These specific tools designed for learning analytics are referred to as ***learning dashboards***, with a more targeted scope compared to other reporting tools. Learning dashboards are learning analytics applications based on the visualization and presentation of interaction data in online learning environments to enable students to monitor their own learning processes (Verbert et al., 2013). Learning (analytics) dashboards can be defined as platforms that visualize a large amount of data about learners' learning experiences and present them on a single screen (Schwendimann et al., 2016).

Learning analytics dashboards are categorized into three main categories: descriptive, predictive, and prescriptive analytics (Daniel, 2015; Sampson, 2016). ***Descriptive analytics*** analyze and visualize the data obtained from the learning environment and aim to discover meaningful patterns, while ***predictive analytics*** use student characteristics, interaction data in the learning environment, and past patterns to make meaningful predictions about future learning outcomes (Kokoç & Hayıt, 2020). ***Prescriptive analytics*** aim to provide recommendations on what needs to be done to achieve the targeted learning outcomes and provide inferences that can be directly used in educational decision-making processes (Kokoç & Altun, 2021).

Learning dashboards have recently been used more frequently, especially in higher education institutions that provide online and blended learning (Han et al., 2021; Kokoç & Altun, 2021). These dashboards entail the collection of students' interaction data and the provision of personalized feedback in various formats, including text, visuals, and suggestions (Bodily & Verbert, 2017). Through learning dashboards, learners are provided with real-time, weekly, and monthly feedback (Bodily et al. 2018; Giannakos, 2022) via email, early alerts, and visualization techniques (Altun & Kokoç, 2019) about indicators of learning such as their cognitive performance (Wan et al., 2019), emotional status (Ez-Zaouia, Tabard, & Lavoué, 2020), behavioral engagement (Kokoç & Altun, 2019). Past studies indicate that the utilization of learning analytics dashboards can aid students in developing a deeper self-awareness of their learning progress and help educators identify students who may be encountering learning difficulties (Kokoç & Altun, 2021; Ramaswami, Susnjak, Mathrani, & Umer, 2023). Recent evidence suggests that learning analytics dashboards have the potential to reconnect students with their learning purpose, serving as reminders of their goals and encouraging reflection about their learning journey (Kokoç & Kara, 2021). A recent study concluded that learning analytics dashboards supported collaborative work and improve the collaborative learning experience (Zamecnik et al., 2022). In addition, the design of learning analytics dashboards can be tailored as instructional tools, providing support for the learning process, addressing potential learning loss, and contributing to an increase in learners' attainment of desired learning outcomes (Alam et al., 2023).

Learning analytics, with a focus on reporting data about learners and optimizing learning and the environment, adopts a learner-centric approach. In contrast, teaching analytics is oriented towards aiding educators in analyzing and improving learning designs, both pre and post-delivery, thus positioning its target audience as instructor-centric (Khuzairi et al., 2020).

Teaching Analytics in Higher Education

Teaching analytics can be defined as "*a new theoretical approach that combines teaching expertise, visual analytics and design-based research, to support the teacher with diagnostic and analytic pedagogical ability to improve the quality of teaching*" (Ndukwe & Daniel, 2020, p.2). Teaching analytics encompasses the methods and digital tools that support educators in analyzing and enhancing learning designs prior to their delivery (Khuzairi, Sidhu, & Cop, 2020). It has the potential to leverage teaching capability. The literature approaches the concept of teaching analytics in two distinct ways. Certain studies involve the examination of educational data to evaluate teacher performance (Ndukwe & Daniel, 2020), while others center on utilizing teacher-facing learning analytics dashboards to process learning analytics data. The goal is to provide teachers with insights for the improvement of students' learning processes (Kaliisa & Dolonen, 2023). Hence, many of these research works portray "*learning analytics for teachers*" rather than "*teaching analytics*" in a literal sense (Prieto, Sharma, Dillenbourg, & Jesús, 2016). Essentially, it yields two significant outcomes: informing learning design and offering real-time feedback on activities transpiring within the classroom (van Leeuwen, 2019; van Leeuwen, Teasley, & Wise, 2022). Bennacer (2022) identified 18 studies specifically centered on teaching analytics in the literature, allowing us to propose a categorization of teaching analytics studies based on objectives, resulting in six goals:

- Feedback about students
- Teachers' behavior analysis
- Recommendation for teachers
- LMS usage analysis
- Course classification
- Teaching evaluation and improvement

Instructors can utilize data derived from their teaching experiences for reflective analysis of pedagogical design, optimizing the learning environment to meet the diverse needs and expectations of students. Applications of educational data empower instructors to make data-driven decisions in ways unprecedented (Singelmann & Ewert, 2022). Teaching analytics can be conceptualized as a rethinking of learning analytics, emerging with a focus on enhancing the quality of teaching and learning outcomes. It takes center stage in technology-enhanced learning (Flavin, 2017). In this context, analytics dashboards, rooted in teaching analytics, possess the potential to assess the performance, make informed decisions, and strategize future activities (Sedrakyan et al., 2020; Williamson & Kizilcec, 2022), owing to the real-time feedback offered on learner performance (Jivet et al., 2021). Teaching analytics tools have the potential to enhance teachers' awareness of student learning and enable them to make informed decisions aimed at improving their teaching.

There are few development studies in the literature within the scope of teaching analytics. One of these research endeavors undertook a case study to examine how machine learning techniques could be utilized to automatically extract teaching actions during the enactment of classroom activities (Prieto et al., 2016). The study utilized five data sources collected through wearable sensors and permitted the automatic detection of the teacher's activity. Regueras et al. (2019) introduced a method leveraging Learning

Management System data to automatically certify teachers' competencies, aiding universities in strategic decision-making. The approach utilized variables linked to both the teacher and students, employing three clustering methods to identify six types of courses used for teacher certification. Van Leeuwen et al. (2019) created dashboards designed for teachers, each providing distinct layers of information (mirroring, advising, and alerting). Another outstanding study utilized a collaborative design approach to create effective translucent learning analytics tools tailored for teamwork in clinical simulations (Martinez-Maldonado et al., 2020). Feedback from four engaged teachers and subject coordinators revealed that the proxy visualizations produced in the process supported teachers in reflecting on their pedagogical methods. In particular, the visualized traces of nurses' activities played a crucial role in refining the learning design. In accordance with a design-based research approach and informed by principles derived from the socio-cultural perspective and human-computer interaction, Kaliisa and Dolonen (2023) created, tested, and appraised a learning analytics dashboard tailored for teachers in authentic educational settings. The primary objective of this dashboard is to aid instructors in online environments by offering insights into students' participation and discourse patterns. Overall, these studies underscore that the primary aim of teaching analytics is to guide educational researchers in developing enhanced strategies that facilitate the improvement of teachers' data literacy skills.

The proficiency of educators in understanding and utilizing educational data which is conceptualized as educational data literacy skills is a crucial factor in attaining the desired results of teaching analytics dashboards. A systematic review study concluded that numerous instructors have continued to face challenges in comprehending and interpreting dashboards, primarily due to a deficiency in data literacy skills and largely attributed to the fact that many tools are designed without involving teachers as collaborative partners (Ndukwe & Daniel, 2020). This result highlights the importance of equipping instructors in higher education with educational data literacy skills. Therefore, it is necessary to develop teachers' educational data literacy skills in the studies to be carried out for teaching analytics in higher education.

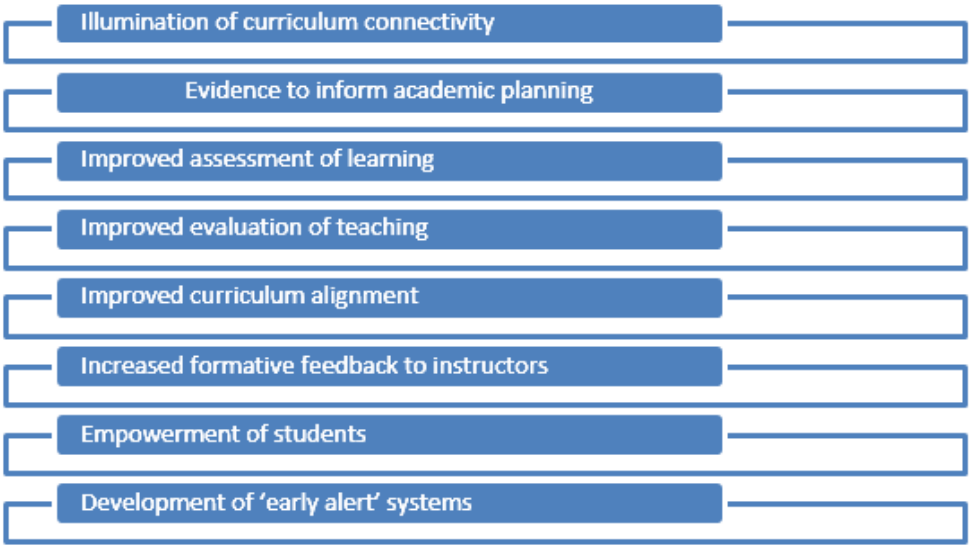
Academic Analytics

Academic analytics refers to the process of discerning significant patterns within educational data in order to develop practical approaches, encompassing the allocation of financial resources and human personnel. In an alternative definition, Academic Analytics is described as the procedure of assessing and analyzing data from university systems, with the purpose of generating reports and supporting decision-making processes (Ferreira & Andrade, 2016). It also serves to provide information on academic matters such as attendance and achievement levels (Ifenthaler, 2017). Academic analytics is viewed within an institutional context, and its outcomes are anticipated to inform the policies of educational institutions. Some studies use the concept of institutional analytics instead of academic analytics (Macfadyen, 2022).

Academic analytics facilitates students and faculty in tracking their career and professional trajectories. It serves as a tool empowering higher education institution to make data-driven decisions across diverse areas, including student success, quality management, promotion, and resource allocation. Academic Analytics involves collecting data on the performance of academic programs to inform policy. It entails utilizing data analysis and interpretation within the academic context to bolster decision-making processes and enhance educational outcomes. It encompasses various analytical approaches such as learning analytics, academic advising, and curriculum mapping (Wang & Orr, 2019; Méndez et al., 2014). For instance, it involves the use of descriptive and predictive analysis in higher education to support operational and financial decision-

making (Wang & Orr, 2019). Furthermore, academic analytics can aid in identifying trends and patterns in student performance, which can be valuable for improving teaching strategies and student retention (Howell et al., 2017; Buerck, 2014). Figure 3 presents a comprehensive overview of the fundamental capabilities of learning analytics, exemplifying the wide range of educational stakeholders and objectives that various methodologies can cater to (Macfadyen, 2022).

Figure 3. *Affordance of Analytics for Higher Education Institutions (Macfadyen, 2022)*



In addition, with these affordances, it also plays an important role in addressing academic dishonesty behaviors, aiming to uphold the quality of education by mitigating actions that hinder students' creativity and analytical skills (Mulisa, 2016). One example of academic analytics in action is the application of assessment analytics, which provides educators with greater insight into staff and student performance on written assignments (Reed, 2014). Additionally, academic analytics can be instrumental in curriculum mapping within medical and healthcare education, utilizing visual analytics and learning objective databases to enhance the effectiveness of the curriculum (Komenda et al., 2015). Moreover, it has been highlighted those academic analytics, along with learning analytics, is essential for accessing and analyzing large volumes of data in educational organizations, particularly in the context of big data in educational systems (Umezuruike & Ngugi, 2020).

Analytics tools such as Ou Analyse for the Open University (Herodotou et al., 2020), Course Signals for Purdue University (Arnold & Pistilli, 2012) and Lathee for University of Cuenca (Broos et al., 2020) are examples of academic analytics. Course Signals project utilized academic analytics to actively monitor students' performance and engagement in a course, identifying those at risk and sending intervention messages outlining relevant sources of assistance. The tool was designed to enhance student success, retention, and graduation rates (Arnold & Pistilli, 2012). An additional instance of academic analytics is found in the advising dashboard known as LISSA. LISSA stands as a successful example, wherein the advising dashboard, originally conceived through a bottom-up approach to streamline advising dialogues between academic advisors and students, was smoothly incorporated into the institutional systems, processes, and practices of KU Leuven (De Laet, 2023).

Academic analytics have the potential to develop personalized educational programs aligned with students' requirements, enhance academic performance, and offer

career recommendations. In addition to academic analytics examining applications at various levels, student-level analytics encompassing teaching effectiveness, financial impact, admission profiles, predictive analysis, post-school employment evaluations, and course recommendations can be undertaken. In summary, academic analytics encompasses a range of analytical methods and techniques that are applied in the academic setting to improve decision-making, enhance educational quality, and support student success. It plays a pivotal role in leveraging data to gain insights into student performance, assessing higher education institutions' performance, curriculum effectiveness, offering career guidance to students, and institutional decision-making processes. Thus, academic analytics in higher education needs to be effectively deployed in quality processes and policy development, contributing to decision-making for improvement and enhancing international visibility.

Conclusion and Recommendations

The vast volume of educational data presents distinctive opportunities to enhance educational environments and support the learning process. Within this context, there are subfields of research dedicated to analyzing educational data for the improvement of education and learning, aiming to derive practical outcomes. In the literature, diverse concepts surface, encompassing learning analytics, educational analytics, educational data mining, teaching analytics, analytics for learning, writing analytics, and video analytics. In addition, educational data applications can be conceptualized in different ways according to different perspectives. According to Reich (2022), research on learning at scale has provided valuable insights into what can be referred to as "*educational policy analytics*"—studies examining how learners from various life circumstances utilize learning technologies differently. Additionally, there has been exploration into "*education behavior analytics*," investigating how individuals click and engage on online learning platforms. While these concepts focus on different technologies or different user behaviors, their main goal of educational data applications in higher education is to *improve learning by enhancing learning experience*.

The prevailing body of literature on learning analytics research and implementation predominantly revolves around higher education (Macfadyen, 2022). In the realm of higher education, universities and institutions are actively engaging in forward-looking initiatives to leverage the potential of learning analytics, conducting preparatory studies for future implementation, and using cutting-edge technologies (Ifenthaler, Mah & Yau, 2019; Scheffel, Tsai, Gašević, & Drachsler, 2022). This collective effort underscores the recognition of the transformative impact that learning analytics, facilitated through dashboards, can have on shaping the future landscape of education. Data on student performance and preferences can be utilized to create personalized learning journey based on their needs. Student enrollment systems and on-campus data can enhance campus services to better meet student requirements. Interaction data of students in learning management systems and their behavioral and cognitive performance in face-to-face learning environments can be used to predict their success, provide educational interventions, and improve the quality of the learning process.

Learning analytics dashboards using educational data in higher education should incorporate a variety of data sources with different characteristics of the learning process, students, instructors, and stakeholders. In this context, the meaningful integration of data from sub-units within higher education institutions is crucial. It is essential to leverage not only teachers and students, but also administrative transactions and raw data stored in databases. Just as important as data collection and processing is educational data literacy. For studies on educational big data in higher education institutions to fulfill their objectives, faculty members, instructors, administrators, and administrative staff should all possess educational data literacy skills.

In addition to numerous advantages, challenges accompany the implementation of educational data applications and analytics in higher education. One notable challenge is the adoption process of educational data applications and analytics, with several issues requiring attention in the incorporation of learning analytics in higher education. Academics' lack of readiness and concerns about data ownership, privacy, and stakeholder involvement are significant barriers (Howell et al., 2017; Wong et al., 2018). Moreover, the challenges arise from the socio-technical nature of learning analytics and the complexities associated with the adoption of innovations in higher education institutions (Gašević et al., 2019). Organizational factors, including institutional structures, commitment, resources, readiness, capacity, and the absence of incentives and rewards, create barriers to the implementation and adoption of learning analytics (Lester et al., 2017). Furthermore, ethical concerns related to educational data ethics are considered hindering factors in the application of learning analytics in higher education (Guan et al., 2023). The challenges of ethics and privacy in analytics and educational data applications within higher education are multifaceted, encompassing legal, technological, and ethical dimensions. Addressing these challenges requires a comprehensive approach that considers legislative initiatives, technological design, and the perspectives of students and other stakeholders. These potential barriers need to be considered if there is a desire to expand and utilize big data applications and create analytics policies in Turkish higher education.

References

Alam, M. I., Malone, L., Nadolny, L., Brown, M., & Cervato, C. (2023). Investigating the impact of a gamified learning analytics dashboard: Student experiences and academic achievement. *Journal of Computer Assisted Learning, 39*(5), 1436-1449. https://doi.org/10.1111/jcal.12853

Altun, A., & Kokoç, M. (2019). Following the learners' traces: Profiling learners and visualizing the learning process for building better learning experiences. In *Emerging Trends in Learning Analytics* (pp. 100-121). Brill Publications.

Arnold, K. E., & Pistilli, M. D. (2012, April). Course signals at Purdue: Using learning analytics to increase student success. In Proceedings of the *2nd international conference on learning analytics and knowledge* (pp. 267-270).

Bai, X., Zhang, F., Li, J., Guo, T., Aziz, A., Jin, A., & Xia, F. (2021). Educational big data: Predictions, applications and challenges. *Big Data Research, 26*, 100270. https://doi.org/10.1016/j.bdr.2021.100270

Banihashem, S., Aliabadi, K., Ardakani, S., Delaver, A., & Ahmadabadi, M. (2018). Learning analytics: a systematic literature review. *Interdisciplinary Journal of Virtual Learning in Medical Sciences, 9*(2). https://doi.org/10.5812/ijvlms.63024

Bennacer, I. (2022). *Teaching analytics: Support for the evaluation and assistance in the design of teaching through artificial intelligence* (Doctoral dissertation, Le Mans Université).

Broos, T., Hilliger, I., Pérez-Sanagustín, M., Htun, N. N., Millecamp, M., Pesántez-Cabrera, P., ... & De Laet, T. (2020). Coordinating learning analytics policymaking and implementation at scale. *British Journal of Educational Technology, 51*(4), 938-954. https://doi.org/10.1111/bjet.12934

Buerck, J. (2014). A resource-constrained approach to implementing analytics in an institution of higher education: an experience report. *Journal of Learning Analytics, 1*(1), 129-139. https://doi.org/10.18608/jla.2014.11.7

Daniel, B. (2014). Big Data and analytics in higher education: Opportunities and challenges. *British Journal of Educational Technology, 46*(5), 904–920. https://doi.org/10.1111/bjet.12230

De Laet, T. (2023). Learning dashboards for academic advising in practice. In *Practicable Learning Analytics* (pp. 55-75). Cham: Springer International Publishing.

Ez-Zaouia, M., Tabard, A., & Lavoué, E. (2020). EMODASH: A dashboard supporting

retrospective awareness of emotions in online learning. *International Journal of Human-Computer Studies, 139*, 102411.

Ferreira, S. A., & Andrade, A. (2016). Academic analytics: Anatomy of an exploratory essay. *Education and Information Technologies, 21*, 229-243. https://doi.org/10.1007/s10639-014-9317-9

Flavin, M. (2017). *Disruptive technology enhanced learning: The use and misuse of digital technologies in higher education*. Palgrave Macmillan London. https://doi.org/10.1057/978-1-137-57284-4

Gašević, D., Tsai, Y., Dawson, S., & Pardo, A. (2019). How do we start? an approach to learning analytics adoption in higher education. *International Journal of Information and Learning Technology, 36*(4), 342-353. https://doi.org/10.1108/ijilt-02-2019-0024

Guan, X., Feng, X., & Islam, A. (2023). The dilemma and countermeasures of educational data ethics in the age of intelligence. *Humanities and Social Sciences Communications, 10*(1). https://doi.org/10.1057/s41599-023-01633-x

Herodotou, C., Rienties, B., Hlosta, M., Boroowa, A., Mangafa, C., & Zdrahal, Z. (2020). The scalable implementation of predictive learning analytics at a distance learning university: Insights from a longitudinal case study. *The Internet and Higher Education, 45*, 100725. https://doi.org/10.1016/j.iheduc.2020.100725

Howell, J., Roberts, L., Seaman, K., & Gibson, D. (2017). Are we on our way to becoming a "helicopter university"? academics' views on learning analytics. *Technology Knowledge and Learning, 23*(1), 1-20. https://doi.org/10.1007/s10758-017-9329-9

Ifenthaler, D. (2015). Learning analytics. In J. M. Spector (Ed.), *The SAGE encyclopedia of educational technology* (Vol. 2, pp. 447–451). Thousand Oaks, CA: Sage.

Ifenthaler, D. (2017). Learning analytics. In K. Peppler (Ed.), *The SAGE encyclopedia of out-of-school learning* (pp. 417–420). Thousand Oaks, CA: SAGE Publications.

Ifenthaler, D., Mah, D.-K., & Yau, J. Y.-K. (2019). Utilising learning analytics for study success. Reflections on current empirical findings. In D. Ifenthaler, J. Y.-K. Yau, & D.-K. Mah (Eds.), *Utilizing learning analytics to support study success* (pp. 27–36). Cham: Springer.

Jivet, I., Wong, J., Scheffel, M., Valle Torre, M., Specht, M., & Drachsler, H. (2021, April). Quantum of Choice: How learners' feedback monitoring decisions, goals and self-regulated learning skills are related. In *LAK21: 11th International Learning Analytics and Knowledge Conference* (pp. 416-427).

Kaliisa, R., & Dolonen, J. A. (2023). CADA: A teacher-facing learning analytics dashboard to foster teachers' awareness of students' participation and discourse patterns in online discussions. *Technology, Knowledge and Learning, 28*(3), 937-958. https://doi.org/10.1007/s10758-022-09598-7

Kokoç, M., & Hayıt, T. (2020). Learning analytics dashboards: Process of design and development of mobile analytics application. In E. Keleş, & M. Kokoç (Eds.), *Current Learning Technologies and Material Design* (pp. 253-288). Ankara: Pegem Academy Publishing. https://doi.org/10.14527/9786257880381

Kokoç, M., & Altun, A. (2021). Effects of learner interaction with learning dashboards on academic performance in an e-learning environment. *Behaviour & Information Technology, 40*(2), 161-175. https://doi.org/10.1080/0144929X.2019.1680731

Kokoç, M., & Kara, M. (2021). A multiple study investigation of the evaluation framework for learning analytics. *Educational Technology & Society, 24*(1), 16-28.

Khuzairi, N. M. S., Sidhu, M. S., & Cob, Z. C. (2020). Learning analytics and teaching analytics: The similarities and differences. *International Journal of Humanities, Management and Social Science (IJ-HuMaSS), 3*(2), 52-58.

Lester, J., Klein, C., Rangwala, H., & Johri, A. (2017). Learning analytics in higher education. *Ashe Higher Education Report, 43*(5), 9-135. https://doi.org/10.1002/aehe.20121

Li, J., & Jiang, Y. (2021). The research trend of big data in education and the impact of

teacher psychology on educational development during COVID-19: A systematic review and future perspective. *Frontiers in Psychology, 12*, 753388. https://doi.org/10.3389/fpsyg.2021.753388

Long, P. D., & Siemens, G. (2011). Penetrating the fog: Analytics in learning and education. *Educause Review, 46*(5), 31–40.

Macfadyen, L., Lockyer, L., & Rienties, B. (2020). Learning design and learning analytics: snapshot 2020. *Journal of Learning Analytics, 7*(3), 6-12. https://doi.org/10.18608/jla.2020.73.2

Macfadyen, L. (2022). Institutional implementation of learning analytics: current state, Challenges, and guiding frameworks. Lang, C., Siemens, G. Wise, AF, Gašević, D., Merceron, A. (eds.) *Handbook of Learning Analytics* (2nd ed). Vancouver, Canada: SOLAR.

Martinez-Maldonado, R., Echeverria, V., Fernandez Nieto, G., & Buckingham Shum, S. (2020, April). From data to insights: A layered storytelling approach for multimodal learning analytics. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (pp. 1-15).

Méndez, G., Ochoa, X., Chiluiza, K., & Wever, B. (2014). Curricular design analysis: a data-driven perspective. *Journal of Learning Analytics, 1*(3), 84-119. https://doi.org/10.18608/jla.2014.13.6

Mougiakou, S., Vinatsella, D., Sampson, D., Papamitsiou, Z., Giannakos, M., & Ifenthaler, D. (2023). *Educational data analytics for teachers and school leaders*. Springer Nature. https://doi.org/10.1007/978-3-031-15266-5

Mulisa, F. (2016). The prevalence of academic dishonesty and perceptions of students towards its practical habits: implication for quality of education. *Science Technology and Arts Research Journal, 4*(2), 309. https://doi.org/10.4314/star.v4i2.43

Prieto, L. P., Sharma, K., Dillenbourg, P., & Jesús, M. (2016, April). Teaching analytics: towards automatic extraction of orchestration graphs using wearable sensors. In *Proceedings of the Sixth International Conference on Learning Analytics & Knowledge* (pp. 148-157).

Ramaswami, G., Susnjak, T., Mathrani, A., & Umer, R. (2023). Use of predictive analytics within learning analytics dashboards: A review of case studies. *Technology, Knowledge and Learning, 28*(3), 959-980. https://doi.org/10.1007/s10758-022-09613-x

Reich, J. (2022). Learning analytics and learning at scale. Lang, C., Siemens, G. Wise, AF, Gašević, D., Merceron, A. (eds.) *Handbook of Learning Analytics* (2nd ed). Vancouver, Canada: SOLAR.

Regueras, L. M., Verdú, M. J., De Castro, J. P., & Verdu, E. (2019). Clustering analysis for automatic certification of LMS strategies in a university virtual campus. *IEEE Access, 7*, 137680-137690. https://doi.org/10.1109/ACCESS.2019.2943212

Scheffel, M., Tsai, Y. S., Gašević, D., & Drachsler, H. (2022). Learning analytics policies. In *Handbook of learning analytics* (pp. 232-240). Society for Learning Analytics Research.

Sedrakyan, G., Malmberg, J., Verbert, K., Järvelä, S., & Kirschner, P. A. (2020). Linking learning behavior analytics and learning science concepts: Designing a learning analytics dashboard for feedback to support learning regulation. *Computers in Human Behavior, 107*, 105512. https://doi.org/10.1016/j.chb.2018.05.004

Singelmann, L. N., & Ewert, D. L. (2022). Leveraging the innovation-based learning framework to predict and understand student success in innovation. *IEEE Access, 10*, 36123-36139. https://doi.org/10.1109/ACCESS.2022.3163744

Stoyanov, S. and Kirschner, P. (2023). Text analytics for uncovering untapped ideas at the intersection of learning design and learning analytics: Critical interpretative synthesis. *Journal of Computer Assisted Learning, 39*(3), 899-920. https://doi.org/10.1111/jcal.12775

Umezuruike, C. and Ngugi, H. (2020). Imminent challenges of adoption of big data in educational systems in sub-saharan Africa nations. *International Journal of*

Recent Technology and Engineering, 8(5), 4544-4550. https://doi.org/10.35940/ijrte.e6885.018520

Wang, R. and Orr, J. (2019). Use of data analytics in supporting the advising of undecided students. *Journal of College Student Retention Research Theory & Practice, 23*(4), 824-849. https://doi.org/10.1177/1521025119880819

Williamson, K., & Kizilcec, R. (2022, March). A review of learning analytics dashboard research in higher education: Implications for justice, equity, diversity, and inclusion. In *LAK22: 12th International Learning Analytics and Knowledge Conference* (pp. 260-270).

Wong, B., Li, K., & Choi, S. (2018). Trends in learning analytics practices: a review of higher education institutions. *Interactive Technology and Smart Education, 15*(2), 132-154. https://doi.org/10.1108/itse-12-2017-0065

Van Leeuwen, A. (2019). Teachers' perceptions of the usability of learning analytics reports in a flipped university course: When and how does information become actionable knowledge? *Educational Technology Research and Development, 67*, 1043-1064. https://doi.org/10.1007/s11423-018-09639-y

van Leeuwen, A. (2023). Teachers' experiences of monitoring their students in online higher education: recommendations for course design and opportunities for learning analytics. *Technology, Pedagogy and Education*, 1-16. https://doi.org/10.1080/1475939X.2023.2254297

Zamecnik, A., Kovanović, V., Grossmann, G., Joksimović, S., Jolliffe, G., Gibson, D., & Pardo, A. (2022). Team interactions with learning analytics dashboards. *Computers & Education, 185*, 104514. https://doi.org/10.1016/j.compedu.2022.104514

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