IFE Insights Reports

Learning Analytics:
The Power of Data in Education

Tecnológico de Monterrey

Institute for the Future of Education

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Prologue

Not long ago, standardized instruments and qualitative judgments governed education. This approach, while functional, also had its limitations. Standardized testing, while a convenient way to assess large groups of students uniformly, often did not capture the complexity of each individual's learning. Results dictated much of the educational agenda, determining school policies, teaching programs, and, in some cases, school funding.

However, today's demands have evolved significantly. Student diversity has become a hallmark of many modern classrooms, with people coming from diverse cultural, linguistic, socio-economic, and learning backgrounds. This demographic shift has posed complex challenges for educators and institutions, who are now faced with the task of providing an equitable and effective education for all, regardless of their individual differences.

In addition, the increasing pressure for measurable results has intensified the need for more sophisticated and personalized approaches to academic assessment. Expectations from parents, communities, and policymakers have changed, demanding greater transparency and accountability in school performance. In response to these requirements, Learning Analytics (LA) emerges as an essential and powerful tool.

LA can be used to collect and analyze detailed data on student performance at both the individual and group levels. It goes beyond simply measuring results on standardized tests; it offers a continuous, contextualized assessment of students' academic and social-emotional progress throughout their academic development. By using advanced data analysis algorithms and techniques, LA tools can identify patterns, trends, and areas for improvement that might otherwise go unnoticed in more traditional assessments.

In this sense, LA not only complements but also enriches and broadens the scope of conventional education. It provides teachers with a deeper and more complete view of each student's strengths and weaknesses, thus making it easier to customize learning and implement more effective educational interventions. In turn, it addresses the critical ability to dynamically adapt to the changing needs of learners in a diverse and heterogeneous educational environment.

It is necessary to picture a future where each student receives personalized education tailored to their individual strengths and weaknesses. LA is the key to this vision, enabling teachers and institutions to adopt real-time strategies and thus maximize students' potential. This report explores how these tools can transform teaching and learning, offering effective solutions to contemporary challenges.

Michael J.L. Fung, Executive Director of the Institute for the Future of Education (IFE)

Preface

In contemporary education, Learning Analytics (LA) emerges as a crucial field that transforms how we understand and optimize educational processes. It has the potential to foster a more inclusive and equitable approach to education. LA tools can help reduce educational disparities and promote fairer opportunities for all students by identifying and addressing learning gaps between different groups of students. This benefits students individually and strengthens the social fabric by ensuring that young people have access to quality education that prepares them to be informed and participatory people in a globalized society.

These tools represent a significant step toward a more student-centered, adaptable, and results-oriented education system. By enabling more accurate and personalized assessment, they not only improve the quality of education but also empower educators to make informed, evidence-based decisions that benefit the entire student body.

Since its conception, LA has faced various challenges, such as the effective integration of technologies that use valuable data without compromising privacy and ethics, since the accurate interpretation of them when making and informing educational decisions remains a constant challenge. However, the benefits of LA are plentiful and significant. Early identification of student performance patterns improves program efficiency and effectiveness and further facilitates the implementation of personalized interventions, which can substantially improve academic outcomes and reduce dropout rates.

This report was created by collaborating with researchers and experts worldwide, who have contributed their insights and knowledge to enrich our understanding of LA. This global contribution underlines the importance of sharing best practices, data, and methodologies to move toward a new educational future and learn from it. The adoption of LA technologies is gaining ground in the Latin American context alone, although it faces unique challenges. The region's cultural and socioeconomic diversity presents opportunities to develop innovative approaches that meet the specific needs of colleges and their local communities.

That is why this report explores how LA is being implemented in various educational institutions, its potential impacts, and the challenges that must be overcome to maximize its effectiveness in the current and future educational context.

José Escamilla de los Santos, Associate Director of the Institute for the Future of Education (IFE)

Introduction

One area that has now undergone major transformations while offering new opportunities for the continuous evolution of the school is the integration of educational technology. It has led to profound changes in the pedagogical practices and structure of learning environments, providing innovative tools that enrich this process and opening the door to various studies that address its impact from diverse perspectives and approaches.[1]

The constant evolution of these technologies and their application in the education sector encourage constant reflection and adaptation of training methodologies, promoting a more dynamic and accessible educational environment. As new tools are developed, new forms of research and analysis also emerge, thus expanding the possibilities for continuous improvement and innovation in the education system.

This expanding field not only transforms current practices but also drives the development of more effective and personalized pedagogical strategies tailored to students' specific needs and contexts.

Learning Analytics (LA) favors the analysis of data about students and their experiences in a way that goes beyond traditional statistics. It provides a vast understanding of what is detected and is a more fruitful and immediate tool, explains Ryan Baker, a professor at the University of Pennsylvania and director of the Penn Center for Learning Analytics.

They are often used to communicate the results of those models and analyses to stakeholders in real time. That is, they are used for both the applica-

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[1] Campos Posada, R., Escribano Hervis, E., Campos Posada, G. E., Boulet Martínez, R. & Vázquez Horta, F. (2022). Analítica del aprendizaje: un desafío al desempeño del personal docente. *Revista Universidad y Sociedad, 14*(6), 40-48. http://ref.scielo.org/f6w3bf

tion of data science in a search for additional information and for communicating those findings through methods such as dashboards. According to Dragan Gašević, an analyst and professor of this topic at Monash University, the purpose of LA is to leverage the data produced during interaction with digital technologies to improve the learning process.

LA is an emerging discipline in the educational field, focused on students and their learning experiences. This study area goes beyond traditional statistics, integrating advanced data science methods to gain a deeper and more nuanced understanding of the educational process. The aim is to transform the data generated during the teaching process into valuable information that can be used to improve learning outcomes. This includes collecting data through various sources, such as online learning platforms, learning management systems, and digital tools used by students.[2] This data covers various aspects, from online behavior to task and assessment performance.

As a field oriented toward the continuous improvement of the teaching and learning process, it is inevitable to focus on its contributions, so this report explores different relevant points within LA, the different models, their close relationship with Artificial Intelligence (AI), and the benefits and challenges of using LA technologies. We also touch on rigorous aspects, such as the ethics involved in using the personal data of the student body, faculty, and other educational actors, with insights from experts worldwide.

2   Universidad Nacional Autónoma de México. (2023). *Las Analíticas de Aprendizaje en las aulas de la UNAM desde diferentes miradas universitarias*. UNAM. https://cuaed.unam.mx/descargas/informe-analiticas-del-aprendizaje.pdf

Learning
Analytics

Learning Analytics (LA) is "an interdisciplinary area where techniques and knowledge of computer science are applied in the area of education," explains Vanessa Echeverría, research fellow in the Centre of Learning Analytics (CoLAM) at Monash University. It focuses on all the actors who exercise some kind of action in the teaching and learning process. It is a field with the main objective of learning from human knowledge, measuring, collecting, analyzing, and reporting data on students.

In essence, students and the way they develop within their learning context are the main priority. What is sought is information to make evidence-based decisions, improve learning processes, optimize learning, and give students the best education experience. Echeverría considers that there are two main topics within LA: the first is to understand how students behave within these educational environments; the second topic is to create tools that enable informed decisions since solving with data-driven information is indispensable for success in any industry. In education, LA allows historical records to be analyzed to improve models, processes, and institutional policies, explains Luis Fernando Morán Mirabal, leader of the Living Lab of the Institute for the Future of Education (IFE) at Tecnológico de Monterrey.

LA collects information, which allows different AI techniques to be used to identify patterns and trends, promoting informed decision-making. Everything is based on statistical models, which are the foundation of all smart models. Natural language processing techniques, computer vision, and generative AI may also be employed.

In this way, Héctor Ceballos Cancino, head of the IFE Living Lab & Data Hub, defines LA as the evolution of educational data mining. Databases contain a wealth of information, so the opportunity was found to improve academic processes by applying AI techniques such as machine learning algorithms. This allows us to understand what happens in a particular classroom or patterns in cycles and programs. Additionally, Morán Mirabal explains that LA is not limited to extracting and analyzing data to generate indicators or forecasts but also to providing actionable feedback, both to teachers and the student body, using those results to enrich their processes.

For example, it can help students identify what skills and knowledge they possess when entering higher education to positively impact those areas. It could even determine the reasons why students

drop out of school or have low academic performance. That is, LA is not limited to just observing and identifying patterns but also to making interventions. However, the intervention is the tricky part.

Isabel Hilliger, assistant professor and deputy director of Measurement, Evaluation, and Quality at the School of Engineering of the Pontifical Catholic University of Chile (UC-Chile), states that LA's promise, from its definition, is to collect, analyze, and visualize educational data to optimize environments. However, at the cross-sectional level in education, it is not about examining data that emerges from the teaching and learning process but rather about ensuring that this analysis, report, and intervention improve said procedure.

Currently, using computer applications to massively use educational data speeds up the process of obtaining the information required to make decisions, says Hilliger. Prior to this, for example, data from evaluation strategies or interventions through surveys were available, a definitely slower method.

By incorporating learning management systems (LMS) or virtual learning environments, it is possible to obtain real-time data on students' interactions with learning resources and teachers, among other things. In this way, there is monitoring, perhaps a closer one, for a better understanding of the development of educational actors. This allows for timely adjustments based on the findings to gain further subject approval, as well as meaningful learning that translates into lower dropout rates.

What is done in the IFE Data Hub?

The members of the IFE Data Hub like to describe it as a restaurant, where they are in charge of finding the ingredients, preparing them, and reviewing the quality of the meals to deliver them in the best way to the diners, that is, the researchers. Thus, the Data Hub is responsible for reviewing the data, ensuring that they are of quality and come from the correct people, verifying that they are updated figures and that they meet the legal requirements of regulations, whether national, international, or institutional. They also play an important role in protecting the data they use, with pre-processing designed to prevent the sensitive data of students, teachers, and other professionals from being recognized.

The IFE Data Hub facilitates access to Institutional Data Collections for members of Tecnológico de Monterrey and international collaborators. In addition, it offers Open Data for researchers in Educational Innovation at a global level.[3]

Joanna Alvarado Uribe, leader of the IFE Data Hub, states that LA comprises data measurement, collection, analysis, and reporting. All of these items are important, but the latter is key, as its purpose is to communicate that a certain outcome was obtained. Another relevant factor of student body data reports is their contexts since they contribute to understanding and optimizing learning and the environments in which it occurs. In this way, it is possible to visualize a cycle without being a linear process, where objectives and metrics are established in the first phase of selecting what to study.

Subsequently, as Alvarado Uribe explains, ways of collecting the data are proposed (or available data is considered, depending on

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3 Institute for the Future of Education Living Lab and Data Hub. (n.d.) *Data Hub*. Tecnológico de Monterrey. https://ifelldh.tec.mx/en/data-hub

the case). Once available, they are visualized and analyzed to explore their validity and curate them. Based on this, models are made to describe, discover, classify, and/or predict situations, patterns, and behaviors. Many authors affirm that there must be stages of evaluation among them, precisely to recognize that actions are carried out to reach the main objective in each phase.

According to Ceballos Cancino, some reports, such as LAK of Direction, which refers to the LAK (Learning Analytics and Knowledge) conference, indicate that not all presented approaches cover learning outcomes or interventions at this event. In other words, there is no deployment of the results. Mainly because, as Ceballos Cancino mentions, there are very high-level approaches, such as those that predict dropping out, but there are also some very low-level ones applied in class. For example, at the beginning of the semester, professors may want to know the level of the group to adapt the course content and provide them with the required knowledge. This includes strategies such as adaptive learning, where when selecting the material or exams, there isn't a need to answer thirty questions, but with ten, it is already possible to determine the assessee's degree of familiarity with a given topic.

Alvarado Uribe explains that in academic programs, it is necessary to validate the impact and have a benchmark or evaluation of the industrial part in order to adjust or improve academic processes. The impact can be measured on an individual basis by promptly analyzing students who have poor school performance or who are at risk of dropping out to provide follow-up and tutoring on aspects identified earlier through the analysis. However, it also involves identifying factors that contribute to improving their engagement, such as cultural and sporting events, among others.

Ceballos Cancino adds that traditional predictive attrition models have been researched for over 50 years, so new approaches indicate that discrimination may exist when a very generic model is produced. He emphasizes that Tecnológico de Monterrey, as an institution, has worked on undergraduate dropouts, carefully studying when to carry out interventions with students in an academic support program based on their differences from regular students. He has even participated in other research demonstrating that, if developed during the first four semesters, critical complex thinking skills will make it easier to achieve optimal performance during the next four semesters, making it easier for students to develop.

When there are different systems, cross-referencing information is a challenge, but using cross-referenced or joint data allows us to support precisely the services that we have as student support strategies. Whether issuing a tutoring recommendation on a certain topic or attacking socioeconomic issues, the process seeks for each student to progress according to their individual interests, motivations, and starting points. Ideally, once the fundamental knowledge has been acquired, a more personalized and anticipatory university education is promoted.

Jessica Alejandra Ruiz Ramírez, coordinator of experimental research at the IFE Living Lab & Data Hub, points out that after the emergency remote teaching period, the transfer of educational processes to the virtual sphere significantly facilitated data capture and highlighted the importance of LA, which became popular as a result. Data science contributes significantly to the pedagogical process, although its effective implementation in real environments faces considerable challenges. Despite its solid theoretical foundation and its ability to visualize the virtual process, multidisciplinary collaboration is essential to maximize its usefulness. This tool allows for a clear view of the virtual education process, but it also requires considerable dedication and a broad perspective to fully realize its in-

formative potential. Fostering multidisciplinary work teams is then necessary to successfully integrate these tools into effective and productive educational practices.

Morán Mirabal emphasizes that learning customization covers a variety of educational scenarios, from traditional to inverted classrooms in remote and hybrid contexts. The effectiveness of each method depends not only on students and teachers but also on the discipline taught. The impact lies in analyzing which approaches and technologies are best suited to different educational models, including cyber-physical environments, which combine the physical and the digital. The goal is to find the best way to teach and customize based on each student's individual needs.

On the other hand, Ruiz Ramírez mentions that the impact of LA is reflected in educational management and the integration of various sources of information to recognize humanity in the teaching-learning process. In cyber-physical environments, LA highlights visible characteristics of students, such as the individual entity. However, it raises questions about the purpose behind technological and pedagogical integration: what is behind these efforts? This underscores the importance of education, not only as a management task but as a means to obtain valuable and clear feedback on the educational path. LA not only guides this path but also involves essential ethical questions in their practical application.

a. Learning Analytics: Unimodal and Multimodal

As previously mentioned, LA refers to the process of collecting, analyzing, and leveraging data related to learning and teaching to improve education. Within LA, there are two general branches that are differentiated by the type of data sources used: unimodal and multimodal learning analytics.

By definition, LA "can use any tool or field that allows them to obtain, describe, analyze, and interpret data on students and their learning processes."[4] In this case, unimodal LA makes use of a single data source. This can be found in educational platforms and technology that can be a single place to register or capture data like Canvas, Coursera, Blackboard or EdX, to name a few. These tools already have varied information that can be extracted to better understand students.

"What does it allow us to do? To capture all interactions. Who speaks the most? Who turns on the camera? Who is active, who is inactive? What words are said? When are they said within the context of a specific task? When are students actually working, and when are they not? Who is sharing their screen? The data that I can capture through Zoom, Teams, or any other video platform can provide all those interactions and all those lines of communication. And what would be the ideal scenario? To be able to identify who is actually working or who is lagging behind in their knowledge or collaborative skills, so that the teacher knows which of their students needs more attention."

- Luis Fernando Morán Mirabal,
Leader of IFE Living Lab

4 Corona, A., Altamirano, M., López, M.A., & González, O.A. (2019). Analítica del aprendizaje y las neurociencias educativas: nuevos retos en la integración tecnológica. *Revista Iberoamericana de Educación, 80*(1), 31-54. https://doi.org/10.35362/rie8013428

IFE Experiential Classroom

With the purpose of integrating advanced technologies to gain a deeper understanding of students' learning, engagement, communication, and collaboration through data collected across multiple modalities, the Tecnológico de Monterrey, through its Living Lab, has developed the IFE Experiential Classroom. This modular 164 m² space is dedicated to Multimodal Learning Analytics (MMLA) projects and incorporates the use of sensors and other technological tools to monitor students' behaviors and interactions in various learning environments without causing them to feel nervous or disturbed by the observation. The Experiential Classroom enables the assessment of factors such as neural activity, physiological biomarkers, oral interactions, eye movements, body postures, and spatial positioning, and their impact on academic performance and student engagement. This provides precise data on which pedagogical approaches are most effective.

Some projects developed previously by the IFE Living Lab team at IFE Experiential Classroom are:

- NPFC-Test: Concentration and motivation evaluation through biometric and facial codification devices in a Human-Computer Interaction (HCI) test.
- GTL-Mars: Teamwork analysis through conversational patterns in a remote collaboration setting, together with MIT (USA), THUAS, and RUG (Netherlands).
- S4L-ET: Attention analysis and interface focus on a logistics simulator through ocular tracking.
- PMCD-Kimen: Concentration evaluation and project management performance through biometric devices and a gamified simulator in collaboration with UTalca (Chile) and EdTech Kimen (Chile).

Two of Living Lab's core pillars are inclusion and diversity. Voluntary participation from different profiles is fomented, which assures a representative sample and avoids bias throughout the studies. Luis Fernando Morán Mirabal emphasizes the need to conduct detailed demographic studies for every experimental setting, assuring that the discoveries can be applied to various populations and academic contexts. In the practical field, activities that combine on-site and remote students are being developed, which use technology to monitor and compare both groups' commitment levels and participation. This experimental focus not only looks to improve the current education experience, but also to serve as a basis for future pedagogical recommendations.

This integrative and multidimensional approach at IFE Experiential Classroom is oriented toward improving the effectiveness of educational technologies and understanding how experiential, physiological, and behavioral factors can impact students' learning and development. It validates educational technologies' usage to ensure that they not only look aesthetically pleasing but also significantly contribute to the academic process.

Morán Mirabal explains that multiple data sources are used in Multimodal Learning Analytics (MMLA), contrary to unimodal LA, which traditionally only uses logs or records. MMLA also incorporates video, audio, gestures, signals, and body measurements to provide a more holistic view of the student's current state.

Morán Mirabal adds that, considering this student information, which occurs and is collected in real time, "it is possible to assess the students' level of attention, for example, or if they are fatigued or comfortable with lighting through sensors from wearables." Having this information about the environment helps improve it in aspects such as turning on the light or the air conditioning, which do affect learning but are only sometimes given due attention. The use of sensors to measure environmental conditions, the comfort of students within facilities, and attention allocation in any given activity enhances LA's multi-learning approach.

Information can be obtained from various sources, such as eye movement, heart rate, body temperature, and electroencephalograms, to recognize patterns on a neuroeducational level. Acquiring data from these sources has a justification in the environment in which the student is immersed. Ruiz Ramírez explains it in a practical way with an experiment carried out in the IFE Living Lab. The experiment studied the performance of entrepreneurial students by presenting their business pitches while using electroencephalograms and bracelets to measure physiological responses during the most important presentations of the semester. In this way, they establish a baseline to understand how they prepare and react to these scenarios, whether simulated or real. They also integrate subjective reports on students' emotional experiences, exploring how they perceive and deal with stress. Ruiz Ramírez says this innovative approach to pedagogy allowed students to reflect on their emotional and physical well-being in an educational setting, an aspect often ignored but crucial for effective learning.

The results of this study allowed the researchers to understand that students with previous experience in entrepreneurship (or belonging to entrepreneurial families) showed better performance and less mental fatigue compared to novices. The aim was to develop tools that would not only assess academic performance but also the intention and entrepreneurial capacity of students in the long term, beyond the classroom, highlighting the importance of emotional well-being in the teaching-learning process and providing new perspectives on how to prepare future entrepreneurs for real-world challenges.

Morán Mirabal and Ruiz Ramírez summarize the process in three phases:
1. The **design** of the study must involve the interested parties, as well as the technical requirements and specifications.
2. Subsequently, during the **execution**, the two main aspects of the process are integrated: the pedagogical and technological. Here, the theoretical bases and indicators to be considered are taken into account, in addition to supporting the physiological and cognitive indicators that will be integrated.
3. Finally, an **analysis** of that data is executed to generate **feedback**.

LA is part of the context of educational technology, which encompasses all tools, platforms, and devices developed to improve the teaching and learning process. However, Morán Mirabal clarifies that these technologies are complementary. For example, a calculator can be a digital tool that facilitates math operations and elevates motivation and class participation. However, it is often used only as a support tool without realizing its full potential. That's why the question arises: What more information can we get from students' interactions with these educational technologies?

The answer goes beyond simply improving learning efficiency or in-

creasing classroom interest. It focuses on collecting and analyzing data generated from these interactions to better understand how students learn and what factors influence their academic performance. This analytical approach makes it possible to identify patterns, trends, and areas for improvement in student learning.

In turn, it could help assess which teaching methods are most effective for a specific group of learners or how digital resources can be customized to suit individual learning needs. Thus, they represent a step forward in integrating educational technology by offering perspectives that not only improve the learning experience but also help educators make informed decisions to optimize the teaching-learning process and support students' integral development.

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b. Artificial Intelligence

LA relates to how AI is applied in the educational field, seeking to perform interventions that improve learning and its different processes, as Ceballos Cancino explains.

AI has helped improve the field of analysis, providing more comprehensive studies and data. In this way, it is possible to quickly and effectively process large amounts of information. It also helps identify complex patterns, knowledge acquired, and warning signs for educators, predict learner performance, and deliver automated reports.[5]

5 Digital Learning Institute. (December 19, 2023). *AI-Driven Evolution in Learning Analytics for Digital Education*. Digital Learning Institute. https://www.digitallearninginstitute.com/blog/ai-driven-evolution-in-learning-analytics-for-digital-education

The field of AI has different branches and approaches, and with LA, it is possible to integrate machine learning techniques, neural networks, and natural language processing, to name a few.

Gerardo Castañeda Garza, collection development coordinator at the IFE Living Lab & Data Hub, establishes that AI has the potential to teach its users through knowledge, depending on how data is accessed and how algorithms are structured. Statistics obtained from student performance can help create meaningful strategies.

"Advances in technology can now enable the interaction of LA with AI, and this can be possible in both education and education research. These two technologies can be combined to better support personalized learning. For example, they can provide a simulation of educational experiences through conversations with a large language model or provide feedback on the learning process and evaluate performance. In the field of research methods, they merge with traditional methods of analysis to identify patterns, trends, or relationships in a larger number of observations."

- Alejandra Magana, Associate Professor of Computing and Information Technology and Engineering Education at Purdue University

Dragan Gašević points out that, in particular, generative AI determines the context in which LA is used. It suggests that this type of technology offers methodologies with the potential to improve learning analysis approaches, so this diagnosis is probably the most effective in understanding the implications of AI in learning, teaching, and education.

Regarding how generative AI influences the implementation of LA, he suggests that, for data modeling and analysis, it may be useful to examine qualitative informa-

tion more simply by measuring zero-shot or few-shot variables. For example, a rubric is created and then applied in student discussion forums. If feedback is desired later, AI is activated to transmit that message in human-like language.

Ryan Baker believes that text data, human tutor dialogues, classroom conversations, and natural language dialogue tutoring have been booming and have become more accessible and feasible areas. However, the generative AI available so far has basic models based on the processing of images, text, and sound, while there is still a need to cover tools based on interactions where there is a student analysis model.

Moreover, he emphasizes the concern that the world might only focus on this branch of AI while ignoring many methods that could solve other problems. For this, he proposes less expensive scenarios, such as exploring the use of ChatGPT or other consolidated

language models to create dialogue tutors that build an intelligent tutoring system on issues in which resources are needed, such as legal reasoning.

The Georgia Institute of Technology implemented a virtual teaching assistant called Jill Watson, which operates with multiple avatars under different pseudonyms for online or in-person activity question-solving. The virtual assistant's most recent version answers questions from new students through an automatic chat. Likewise, it manages to answer administrative questions related to subject evaluations such as tasks, projects, and exams,[6] says Magana.

Castañeda Garza suggests that it is important to stop and consider whether the direction the world is taking is the right one. It is probable that just as the Internet and social media shaped previous generations, the next ones will be influenced by AI. As a result, AI will impact the developing minds of

6   Georgia Tech GVU Center. (n.d.). *Virtual Teaching Assistant: Jill Watson*. Georgia Institute of Technology. https://gvu.gatech.edu/research/projects/virtual-teaching-assistant-jill-watson

children and young people. Just as it has been documented that Instagram algorithms have harmed the mental health of teenagers and young adults,[7] it is critical to identify how these AI risks can be reduced.

This scenario suggests that the teacher's role will be crucial and permanent in implementing LA. During high school students' academic journeys, teachers could use machine learning resources to detect aptitudes for a career and guide them toward their vocation.

According to Gašević, students perceive learning analysis as useful. In projects he has led in Europe, Latin America, and Australia, he found that students expect institutions to use LA. However, they have little confidence in the institutions' ability to implement LA tools effectively. Instead, they believe in

caring for their privacy and ethics and are excited to see the use of generative AI.

Similarly, Gašević explains that students expect educational institutions to promote the use of generative AI as part of their digital literacy growth. In this way, students make smart use of the tools, while teachers and university administration serve as advisors throughout the process.

However, the specialist adds that a much deeper understanding of how students perceive these issues and conceptualize additional threats that can be dealt with in the future is essential. He warns that generative AI may perpetuate gaps, like the digital gap. So, it is not just about access; it is also about knowing how to use these instruments.

7   University of Utah Health. (2023). *The Impact of Social Media on Teens' Mental Health*. University of Utah Health. https://healthcare.utah.edu/healthfeed/2023/01/impact-of-social-media-teens-mental-health

Khan Academy

Khan Academy is a learning platform that has the facility to show content from different subjects to students from primary to higher education. It provides free education. As users answer questions, its algorithm places them at an appropriate level. From there, students can learn about any subject through instructional videos and practice exercises.

This is how this site achieves one of LA's ideals: customized learning. For instance, 30 students could do the same activities, but each one would follow a different path.

A relevant case is the determination of biases. In this regard, generative AI has been shown to have specific inclinations. Castañeda Garza explains that the key is to define who will decide if it is a bias. He explains that UNESCO has international recommendations established by experts in AI, ethics, computational sciences, and other areas who recognize the guidelines to ensure that this technology is used for the good of humanity.

He also adds that there is a wide disparity between the ideal and the practice since private companies have a relevant power when deciding how to take advantage of the tools, orienting themselves to particular interests. The same happens if a specific AI is managed by a government or a non-governmental institution, as they are prone to carry a bias. So, having an AI that works without bias is difficult.

On the other hand, Morán Mirabal details that certain experiments at the IFE Living Lab involve creating assets to facilitate experimental research based on data to attain organic and diverse participation. Open invitations are made to people of different ages, genders, academic programs, and specific conditions, such as the use of glasses or medical conditions, to ensure that the sample is representative and to reduce potential biases. The process includes detailed

demographic studies for each experimental scenario, thus avoiding results that favor specific groups, whether students of a single program or some limiting characteristic during development.

It is essential for the IFE Living Lab to avoid such biases and ensure that the findings are valid and applicable to diverse populations. They also recognize the importance of replicating their studies in different contexts to better understand other communities and their students. Despite the diversity of the student community at Tecnológico de Monterrey, which includes international and foreign students, the commitment to minimize any potential bias through inclusive and equitable experimentation continues.

In the present day, where the heyday of generative AI persists, the 14th International Conference on Learning Analysis and Knowledge (LAK 2024) showcased the benefit of prompts to help prepare the class material. AI generates content, objectives, and activities and reveals where to start. However, Ceballos Cancino warns that it is important to verify whether ChatGPT's output is being taken at

face value without assessing that the information is well formulated. For example, an expert teacher can identify if the output makes sense and find references that support it, but without that filter, those who do not know about the subject and teach it can represent a risk.

Another case addressed during the event highlights interactions with generative AI, as teachers can measure which input is human and which is a machine. This is because prompting ChatGPT to improve a question can be considered a contribution to an academic article. Even if the person provides adequate instruction and the technology has completely written it, the individual remains a participant in the task.

However, one concern is whether the student body is actually learning and being critical. Ceballos Cancino mentions that it depends on how teachers guide students to use the tool. An example would be the difference between asking for a simple essay where students can copy and paste content and preparing a dynamic where ChatGPT's opinion on a topic is criticized.

Gašević points out that adaptive learning systems are about adjusting education to the needs of students. However, he suggests that rather than relying on specific systems, it is crucial for students to develop adaptive skills, particularly in the age of AI. This is because they will encounter an unprecedented rate of change in the professional world.

"It is not the analytics. It is the adaptive learning based on it. It is reporting based on it."

- Ryan Baker, Professor at the University of Pennsylvania and Director of the Penn Center for Learning Analytics

AI consolidates a holistic view of student learning so that, with its tools, student attrition or success can be predicted, academic performance can be improved, and better educational decisions can be made. A balanced approach that combines the potential of technology with human talent and supervision will provide an inclusive and effective teaching process.[8]

iStock.com/Robin Beckham_istock

8 Digital Learning Institute. (December 19, 2023). *AI-Driven Evolution in Learning Analytics for Digital Education*. Digital Learning Institute. https://www.digitallearninginstitute.com/blog/ai-driven-evolution-in-learning-analytics-for-digital-education

c. Learning Analytics
Applications and Benefits

When it comes to LA in education, its use seeks to benefit the entire university community, from the individuality of each student to the educational institution as a whole, which can make decisions that impact all its members based on LA.

LA is responsible for examining data that can be of great support to any institution that seeks to understand in depth the context in which it finds itself. The Society for Learning Analytics Research (SoLAR) defines four types of methodologies[9] to obtain different types of information:

■ **Descriptive analytics:** This methodology reviews historical data, such as student engagement rates or graduate results and opinions, to understand the context of the past.

■ **Diagnostic analytics:** This methodology uses diagnosis tools to better understand "why" something happened. By examining records, irregularities or deviations that resulted in a specific circumstance can be found, either through the collection of information through correlations, data processing, or data mining.

■ **Predictive analytics:** This methodology makes predictions based on the data collected (understanding that LA cannot "guess" the future). These predictions can help users prepare for upcoming trends based on current variables.

■ **Prescriptive analytics:** This methodology aims to provide personalized recommendations through automated algorithms and machine learning, among other technologies. Student activity is reviewed to provide suggestions based on downloaded content and videos watched, among other actions.

LA can be a very broad concept, with multiple attractive offers that bring many benefits, but choosing the most suitable one will depend on each institution's possibilities and needs. However, the most significant advantages for each group will be divided into three sectors within educational entities:

■ **Students**

LA can contribute to student motivation. In Ryan Baker's experience, students tend to appreciate their teachers' messages much

9   Digital Learning Institute. (September 6, 2022). *Learning Analytics: The Ultimate Guide*. Digital Learning Institute. https://www.digitallearninginstitute.com/blog/learning-analytics-the-ultimate-guide

more when they are accompanied by their reports, as they feel that they care about their academic well-being. On the one hand, an analysis supported by evidence will not only make students feel appreciated but also allow them to have a deeper assessment of their performance through figures and the knowledge of their teacher. On the other hand, students may feel the opposite when receiving results sent solely and directly by the system, without any observation from the teacher.

"A lot of times, it comes down to what the user experience is rather than the analytics. I think, ultimately, analytics supports good interactions and bad interactions, and people can tell the difference. And it's the interactions that they value and care about, not the analytics that underpins it."

- Ryan Baker, Professor at the University of Pennsylvania and Director of the Penn Center for Learning Analytics

LA can play a very important role in student retention. Joanna Alvarado Uribe says that different analyses can be conducted on various student groups at the career, school, and region levels. For example, using information from their admissions process, we can review which career had the highest dropout rate, which students are most likely to drop out, or how prepared they were from certain high schools. This data allows a university to take action on the matter and design leveling strategies before students enter, focusing on the areas of opportunity of a particular group to avoid early abandonment.

She also mentions that interventions must be timely and efficient precisely because the reason behind a given situation is known or sought. In the case of *Canvas*, the platform helps teachers access relevant information on the activities carried out by their students, as well as evidence of their projects. It also provides students with flexible learning where they can revisit content and recordings, par-

ticipate in discussion forums, or solicit feedback from their teachers. It is in this type of tool that the collaboration between teachers and students is reflected, in addition to showing the material that interests them most, which is valuable information for teaching.

As in the previous example, LA encourages students to apply self-learning, helping them to follow their own educational routes by having control over the content they access and when they do it. By identifying students' learning styles and strengths, LA helps university students focus on the areas they need to reinforce or spend less time on concepts they have already mastered.

LA Project

After the pandemic, virtual collaboration became paramount in professional and academic contexts. Given this change, some research professors such as Alejandra Magana, Dominic Kao, Bedrich Benes, and Jennifer Richardson developed the Productive Engagement through Collaborative Action and Sociology (PECAS) Mediator. This tool allows to foster social presence, facilitates teamwork and promotes participation in virtual learning in higher education by detecting team behavior, whether productive or unproductive. Subsequently, the technology is responsible for acting as an intermediary to recommend solutions that improve team collaboration.[10]

"LA is key to helping improve the performance and personalization of teaching-learning processes. Analytics, as such, helps us understand the strengths of the school and the students, as well as identifying areas of improvement and opportunity for both."

- Joanna Alvarado Uribe, Leader of the IFE Data Hub

10 Magana, A., Kao, D., Benes, B., & Richardson, J. (2022). *Productive Engagement through Collaborative Action and Sociology (PECAS) Mediator*. Center for Integrative Research in Computing and Learning Sciences. https://circls.org/project-spotlight/productive-engagement-through-collaborative-action-and-sociology-pecas-mediator

In collaboration with the National Autonomous University of Mexico (UNAM) and the University of Guadalajara (UDG), Ceballos Cancino shared a study of LA expectations from students and teachers through standardized surveys replicated from other countries and continents. The results of the surveys and focus groups show interest in focusing on both students and teachers. To illustrate, the teacher would find a lot of value from the first day of school in knowing their group, the career they are studying, what subjects they have taken, and how much they know about programming, among other issues, and in having a board that indicates how the group is doing, and from this determine how they will proceed.

Likewise, some findings of this study imply that, rather than caring about the fact that there is access to their information, students care about the insights that are obtained in return. Students expect customized learning. When they know what area of their career they want to target, they want resource recommendations, information, diplomas, or certifications that will help them enter the job market quickly upon graduation.

■ Teachers

Teachers have many activities in their hands since they not only teach classes but also perform other tasks, from attending conferences or training to reviewing tasks or managing their students' attendance, which can be tedious, repetitive, and time-consuming. This is where LA comes in, which can facilitate and even automate these types of processes, giving teachers more time to plan their classes, interact, and provide deeper feedback to their students. "By reducing the time and effort spent on routine tasks, AI allows educators to focus more on instructing and incentivizing student engagement, significantly improving the educational environment."[11]

Alvarado Uribe explains that LA makes it easier for teachers to have a more visual, timely, and individ-

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11 Emilio, G. (June 5, 2024). *Using AI in Education Use Case 7:10 – Administrative Task Automation*. The Missing Prompt. https://themissingprompt.com/using-ai-in-education-use-case-710-administrative-task/

ualized follow-up of the actions of each student, thus knowing what motivates them and the various ways in which they learn. This is how they can rely on technology to plan a more efficient educational scheme adapted to their students' preferences.

Through feedback, LA can help teachers be retrospective and detect areas for improvement in their teaching process. For example, they can do it through platforms that list the type, format, or style of material that their group consults the most. Another application would be to identify the module that was most difficult for the class and thereby observe and consider teaching alternatives to facilitate understanding of the subject. This would also help determine whether it is necessary to review concepts or carry out another evaluation to level the group.

■ Educational institutions

Baker states that a great benefit of LA is the wide variety of technologies this science offers. These pave the way for multiple applications and for appropriate systems to be in place for all levels of education, from preschool higher education and up to lifelong learning in adulthood. For children, it is better to use platforms that focus on content selection or *Mastery Learning*. For adults, it is more convenient to use systems specialized in detailed, high-quality feedback or tools that provide support for deep and self-learning.

A very important area for institutions is that LA offers an excellent opportunity to reduce costs.[12] Through data examination, decision-makers can predict or see in real time whether any situation, such as a change in curriculum, is working or not. Thus, they can act quickly to make adjustments or decide not to move forward with the project, among other things. Otherwise, this process would be much slower and more expensive, having to resort to tactics such as trial and error to solve problems.

12   Digital Learning Institute. (September 6, 2022). *Learning Analytics: The Ultimate Guide*. Digital Learning Institute. https://www.digitallearninginstitute.com/blog/learning-analytics-the-ultimate-guide

LA requires coordination between various departments and disciplines, such as design, research, education, and more.[13] This coordination fosters a culture of interdisciplinarity within institutions that allows the familiarization of one area with another. Collaboration across disciplines on LA topics allows for faster and more effective communication, as evidenced by the data these tools collect.

For many educational institutions, maintaining high-quality education is paramount, so LA can provide tools to measure their teachers' performance. Through the general performance of students, end-of-course surveys, or tracking of specific data points, institutions can assess the instructional quality of teachers. Some things that could be tracked, for instance, are response times to questions or doubts, content adaptation, use of resources, and interactions with students, among others.

Likewise, LA offers a broader understanding of students to know their community and the factors or situations that are important to them and thus carry out actions to increase their comfort, commitment, and sense of belonging to the institution.

With this information, it would also be possible to collect valuable elements for teachers and showcase them, not only internally but also to an external audience. This allows the institution to attract potential students who share its values and vision. This is how education entities will know who their target market is and can work to create better marketing and communication campaigns.

LA helps institutions at all levels visualize the pace at which students go through different academic stages more clearly and even helps predict how the next generation will behave. Thanks to advances in AI, members of educational communities greatly benefit from the aspects previously discussed. In this way, educational entities can continue to improve the quality of their services and thus contribute to the training of the next generation of leaders.

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13   Ibid.

d. Challenges

Although technologies that involve LA offer numerous benefits, it is important to consider the obstacles they can bring to institutions. These are factors to consider when implementing them, from schools' economic capacity to their cultural and geographical context. However, knowing the possible impediments is part of designing an effective strategy to address the problems and thus obtain relevant results from a successful implementation of LA in the educational field.

The first thing to consider is the institution's level of technological maturity to adopt LA, as well as the actions and systems developing within its facilities. There is a wide range of analytics, so an appropriate level must be chosen for the entity's objectives: the program used by a teacher who performs exercises with their class data will not be the same as establishing a sophisticated system with which the management can make significant decisions and that requires the hiring of mentors to do specific tasks. Defining the reasons for integrating new technologies is essential.

Unfortunately, many institutions focus only on the technological details of LA without opening their panorama to its implementation, nor having a clear vision of what exactly to do with them. Having the latest in digital tools does not equate to good educational innovation.

Additionally, after setting the data usage objectives and strategy, it is imperative to use the results.

Alvarado Uribe highlights that one of the challenges is to consider data curation, that is, that the information obtained from the students is pre-processed to carry out different analytics. When storing records in different systems, the constant support of investigators who are in charge of properly validating, extracting, and documenting them is necessary. Otherwise, they may merely accumulate without being used.

As mentioned above, it is important to emphasize that data is not analyzed on its own. It is essential to describe the data and offer context to understand how it is compiled and linked. In turn, it will lead to a better interpretation of the results. It is best practice to have an enabling area dedicated to collecting, curating, and validating the data.

As part of the work of the IFE Data Hub, Alvarado Uribe affirms that, in order to carry out quality LA, the data owners must be continuously consulted to verify what cannot be seen with the naked eye from the

evidence received. This is to confirm if the information is applicable, to prevent duplication, and to ensure that the dates of the records collected are correct, among other details.

Leaving aside the human capital involved in LA, institutions must evaluate that this type of analytics requires a lot of processing power by technological tools such as computers or servers, so it will be necessary to look for external resources to safeguard the data on one or more platforms to handle massive data.

Another significant challenge is securing access to these servers that act as information banks for many students. It must be recognized that much of the educational data also includes the personal information of the students. This appeals to the sensitivity of the records and the significant risk of an information leak that would affect both the institution and its community if they were not anonymized.

Each institution must develop regulations and transparency policies on the best data usage practices to foster the continuous improvement of the educational process. Moreover, if there aren't guidelines dictated by the country where the institutions are located, they must assess this individually.

Unfortunately, few countries and universities have specific regulations on data protection. This may also result in some institutions, in the desire to protect, limiting their use without comparing the potential benefits against bias from a consequentialist or ethical point of view. However, with the rise of generative AI, many countries have gradually resumed these issues and are reinforcing their laws regarding information privacy.

That said, recognizing the above, the owners of these statistics cannot be left behind: the students. Students trust that their information will be treated appropriately, so Alvarado Uribe expresses that it is necessary to have the sensitivity to continuously convey to

them that the objective is to analyze in order to enhance their academic trajectory. Otherwise, students may feel exposed or unsure that their information is being used improperly or ethically, so constant communication campaigns are needed to clarify that using their data is fully for educational purposes.

With these education campaigns, frustrations that may emerge in the academic community could also be appeased. For example, Yi-Shan Tsai explains that "[...] teachers tend to find themselves 'caught in between,' struggling to fulfill expectations from both managers and students while lamenting the loss of academic autonomy. On the other hand, students find themselves being excluded from the process of decision-making that is based on data about them." [14] Regarding the above, given the risk of a misinterpretation of the data, students

could be forced to do what is expected of them, according to the results obtained, restricting their ability to make decisions in the future or limiting their opportunities.

Following the supervision of student information, the human side of teaching should also not be neglected. Dependence on LA can be counterproductive to students. Ryan Baker explains from prior experience that students can feel unmotivated when they receive feedback from a system. As a result, they may not take responsibility for their tasks, pay less attention to their subjects' requirements, and ultimately produce work of suboptimal quality.

Similarly, so much dependency can lead to a lack of confidence when entering situations where LA technology cannot be used.

Even if it doesn't seem like it, the context the student is in has some impact on the perception of LA. Ceballos Cancino shares an ex-

14   Tsai, Y. (March 3, 2021). *Learning Analytics: 3 Challenges and Opportunities*. SoLar: Society for Learning Analytics Research. https://www.solaresearch.org/2021/03/learning-analytics-3-challenges-and-opportunities/

ample of the significant difference between students in education systems in Latin America and Europe, which was detected through surveys.

On the one hand, European students prefer to follow the subject through boards that indicate the tasks to be carried out and thus decide how and when they will carry them out. On the other hand, Latin American students are closer and more communicative, so they expect constant feedback from their teachers. When incorporating these new technologies, it is crucial that institutions assess how students will need to use them to shed light on the support and guidance they will need.

"Training teachers is also essential so that they have information from their students, because sometimes the teacher has everything to do something, but does not have the data."

- Hector Ceballos Cancino, Director of the IFE Living Lab & Data Hub

Training faculty and institutional leaders in the ideal use of these technologies is critical, and a budget should be estimated for their training. Above all, a challenge to overcome is finding a way for them to be educated efficiently while keeping the costs economically accessible.

Each teacher must be trained in not only their respective areas of expertise, also in the technologies, methodologies, and institutional values of the schools they teach in. When LA tools are used, it must be understood that these will not act independently but that teachers must be trained to read, capture, and effectively use the data collected to enrich their courses.

It should be noted that some teachers will not have the time for training due to the burden of courses, research, or administrative activities that prevent them from delving into these new con-

cepts in depth. Faced with this problem, Alvarado Uribe suggests that institutions find a balance between teacher training and the use of technologies to encourage data analysis that strengthens their class delivery, as well as the academic experience of students.

Teachers need to be given space to learn any new technology, as they require an operator to function correctly. Otherwise, the technology will become unusable and, in some cases, even forgotten.

"What it looks like in reality is that learning analytics may require new forms of infrastructure, system processes, and expertise, which is disruptive to institutional stability and processes. It is thus important to have key leadership that can embrace the tensions, mobilise resources, establish a governance procedure, and importantly, align learning analytics solutions with existing problems that require solving, i.e., a problem-driven strategy rather than a data-driven strategy".

- Yi-Shan Tsai, Professor for the Center for Learning Analytics at Monash University[15]

15 Tsai, Y. (March 3, 2021). *Learning Analytics: 3 Challenges and Opportunities*. SoLar: Society for Learning Analytics Research. https://www.solaresearch.org/2021/03/learning-analytics-3-challenges-and-opportunities/

The implementation of LA requires persistent leadership with a clear vision of the objectives to be achieved. This allows us to see all the obstacles that may prevent the integration of these technologies and design relevant strategies to overcome them.

In addition, interdisciplinarity will be a key factor in expanding academic perspectives, so constant communication with all the parties involved will be essential for institutions to be able to use the information collected productively. This can significantly enrich the academic path, helping university students make the best decisions and enhance their talent.

Meanwhile, Echeverría explains that, in Latin America, LA faces significant challenges due to the lack of advanced technological infrastructure and limited resources in many educational settings. Implementing data capture systems, such as sensors and audio and video recording devices, can be costly and difficult to maintain. In addition, insufficient training of educational staff in the use and analysis of these data, together with the need to adapt technological tools to specific contexts, are additional barriers to fully harnessing the potential of LA in the region.

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Isabel Hilliger shares her participation in the LALA - Building Capacity to Use Learning Analytics to Improve Higher Education in Latin America project from 2017 to 2021. This research by *Learning Analytics for Latin America* sought from the European Commission, which financed the project, to install capacities in the region, especially in higher education, with regard to the adoption of Learning Analytics through the exchange of experiences between European and Latin American universities.

Previously, only isolated initiatives had been observed; however, there was not necessarily a collaboration that reflected an institution's work. Therefore, LALA's effort consisted of generating a community that exchanged experiences of different researchers on possible tools to be adopted to reach a higher level of maturity in the institutions.

The project team established an artifact consisting of a graph showing the differences in maturity against the leadership involved. This artifact serves as a guide in relation to the status of each institution and allows us to know what type of initiatives they have, where they are located, what they have to mobilize, etc. In this count, and from the creation of the instrument, several publications emerged that show different initiatives in Latin America regarding the adoption of LA. Similarly, a model emerged to promote the maturity and adoption of the resources provided by LA.

e. Best Practices

Best practices for using LA involve intelligently and accurately interpreting and using the collected data to optimize resources, enhance students' talent, and positively contribute to their decision-making. By collecting the data, it will be possible to see the behavior of the users, and, in this way, the investigators will be able to understand them and convert this information into strategies to identify gaps and modify the learning processes to close them.[16]

16   Pappas, C. (April 28, 2024). *Analytics for Education: How to Make the Most of Metrics to Improve Student Participation*. eLearning Industry. https://elearningindustry.com/analytics-for-education-how-to-make-the-most-of-metrics-to-improve-student-participation

The following expert recommendations help expand the LA landscape, which encourages personalized learning and educational transformation. Institutions should include these in their vision to prepare their students to react agilely to future trends.

Gašević states that LA is characterized by three key disciplines, all of which are equally important and need to be equally balanced for successful implementation.

- Data science and AI.
- Learning science and education.
- Interface design.

Institutions often make the mistake of not betting on including the three dimensions in their entirety, which can affect the integration of LA into the curriculum. There may be suitable interfaces for data, but the team may not know enough about data science. Or maybe data scientists are excited about the way their algorithms work, but they haven't considered user experience when navigating the platform being used. Keeping these three dimensions in mind at all times will be critical for proper implementation.

Good leadership, with a vision for continuous improvement and ed-

ucational transformation, will be the first step to guiding an educational entity toward a digital evolution that benefits and prepares its graduates in a rapidly changing work environment. Many institutions can count on people with vast technical knowledge or great support from a high-ranking manager. However, Gašević assures that it must be a person who has the skills of an academic leader who understands the impact that LA will have within their academic community while being able to demonstrate and lead the organization toward a positive change in their learning and teaching practices.

After ensuring good leadership, Gašević proposes five basic steps to integrate LA into an academic institution:

1. Understand the political context in which LA is to be implemented. It is not only about studying the policies and situation of the country where the institution is located; it also refers to its internal policies: the dynamics and manner in which educational initiatives are executed, the culture within the academic community, their motivations, and resources, among others.

2. After looking inside the organization, look outside and think about who they are and how to involve the institution's stakeholders.

3. Define and understand the objectives with the inclusion of LA in the entity. Indicate if the integration of technology is for the entire institution or if a smaller group will be established to which it will be directed since not all LA products are intended for the entire school community but for specific problems that may be relevant to a small percentage, which does not mean that they are less important problems to be solved.

4. Determine how to evaluate the implementation of LA and the factors to assess. Moreover, consider the available resources to achieve a successful review of results.

5. Know "how" the entire organization is learning from the use of integrated LA. Establish good practices for knowledge management and organizational learning.

"Learning Analytics is not only technological but also sociotechnological."

- Dragan Gašević, Analyst and Professor of Learning Analytics at Monash University

Gašević considers the above recommendations critical elements. As can be seen, each of them focuses more on people than on the use of technology itself. Care should be taken to focus on incorporating technology into problem-solving, as introducing LA without first thinking about how it will be implemented can be harmful, especially financially. This type of approach results in the technologies having no users and becoming unusable.

Step four, for instance, is often overlooked. The evaluation is key since that is where the system's application is qualified to assess the technology's impact and results, to determine who it worked for and who did not, and to make adjustments based on that. It is a stage that must be contemplated in the concept plan to implement a good strategy based on learning data. Its results will be the response to what must be adapted to endorse the good use of these technologies.

In addition to Gašević's recommendations, transparent communication with the university community regarding data use is needed. To this end, effective communication campaigns and the involvement of other individuals who can disseminate the findings are necessary. Alvarado Uribe argues that, in order to deliver clear messages to an institution's members, an area made up of different multidisciplinary profiles is necessary.

This area requires a team of experts in computing and statistics, as well as those with internal communication, education, or psychology profiles. They should be able to translate the models' results to the student body and decision-makers in a grounded and friendly way without many technicalities for easy understanding.

Castañeda Garza proposes some questions to develop communication campaigns that clarify the topic of LA to the institution:

- **What data does the institution have?**
- **Which area of the institution will be responsible for data management?**
- **How are records handled?**
- **Through which platforms will the information be handled?**
- **How will the data be used?**
- **How will data be protected in computer and social terms?**

Likewise, having an open channel where members of the educational entity can interact and learn more details would be ideal to clarify any doubts, comments, or concerns. Strategies like an email address or a chat channel could help. However, Castañeda Garza mentions that there are institutions, such as the University of Michigan,[17] that have specialized platforms where students can see exactly what information is extracted, as well as the use policies and a helpline, increasing the transparency of the use of their information.

Concerning data, it needs to be classified for proper use and storage. Alvarado Uribe states that having cured, anonymized, and documented data is essential for sharing with researchers from various institutions.

It's also worth noting that the superficial analysis of information obtained through LA does not provide a solution to one or more problems; rather, it will provide predictive information that will serve as a guide to designing an appropriate strategy to address specific situations.[18] It should be noted that LA is limited to not including those external factors that affect the performance of its users.

The area responsible for LA cannot be the only driver for implementing technology. It is from the

17 University of Michigan (2024). *My Learning Analytics*. Information and Technology Services – University of Michigan. https://its.umich.edu/academics-research/teaching-learning/my-learning-analytics

18 Open Educational Resources (OER). *Challenges and Limitations. Learning Analytics.* https://learnonline.github.io/page3.html

proper management of a senior manager or manager, their intentions, the clarity in their objectives, and an interdisciplinary perspective that their vision can permeate the rest of their institution.

When the entire school is involved, technologies will be more readily accepted and understood. It is essential that LA users are the focus of their implementation and not technologies. Technologies are only the means to a greater understanding of each individual's learning and behavior, boosting their capacities and skills to obtain

optimal results that have a positive impact on their future.

Beyond technology, Gašević reflects that LA must be directly related to the students' adaptive and knowledge capacities, and it is necessary to consider how these elements are dealt with. Currently, we live in an era in which everything is standardized. However, LA invites more personalized learning, so it is essential to keep this in mind and take advantage of it so that students can define their learning objectives and create their own paths to achieve them.

LA Project

Vanessa Echeverría explains the Human-Centered Teamwork Analytics project, which is a laboratory that simulates a clinic where students recreate hospital scenarios using mannequins as patients and complete medical equipment. Students are assigned case studies that mimic real hospital situations, where they must prioritize patient care, work as a team, and communicate effectively. Sensors track student locations and capture audio and video, allowing for the analysis of interactions with patients and medical staff.

This data is used to evaluate compliance with protocols and the effectiveness of teamwork. The information is processed in a web application where students review detailed analyses of their practices, allowing them to reflect on their performance. This approach improves feedback on the traditional post-simulation discussion method, empowering teachers with accurate information to provide personalized guidance to each group. The project prepares students more effectively for real-world clinical situations, highlighting areas of improvement in communication and protocol execution.

However, educational entities must abandon the idea of being in control of learning and allow students to create their own processes. More than a technological challenge, it is a structural and even political one, so institutions must be prepared to make way for a significant change that can be tumultuous but beneficial for many.

Good data planning and interpretation through LA will help both senior leaders and the university community make better decisions to enrich their academic development. LA proves to be a great ally in strengthening and transforming the educational environment in a positive way if it is properly implemented with the understanding and support of all members of the institution.

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f. Teaching Practice

Teachers guide students to complete their educational trajectories. These actors play a preponderant role in the teaching-learning process, as they are guides who also provide accompaniment to lead their students to obtain the best possible results.

While educators are actively engaged in learning, there are tools such as LA that support them in being timely facilitators. Through LA technologies, faculty can access more accurate and instant feedback and help their students manage or personalize their learning.[19]

19   Aguilar, X. (2024). *How to successfully integrate learning analytics and AI in education?* Universitat Oberta de Catalunya. https://www.uoc.edu/en/news/2024/how-to-successfully-integrate-learning-analytics-and-ai-in-education

"The way we use the data generated in educational settings can be varied and does not necessarily have to be digital in order to improve the experience for different actors of education. It usually focuses a lot on students, but it can also be on teachers and administrative tasks."

- Gerardo Castañeda Garza, Collection Development Coordinator at the IFE Living Lab & Data Hub

For her part, Alejandra Magana highlights that if the LA data is generated in real time and the analysis is presented to teachers through an interactive panel, they can make decisions and adapt their teaching techniques. Similarly, analytics can feed an AI virtual tutor who guides the student and provides feedback when working outside the classroom.

Isabell Hilliger, professor and researcher in higher education analytics, states that, on occasion, the tradition of LA was to address students or decision-makers and, unintentionally, seek to bypass the teacher's authority. It empowered the student body in their teaching-learning process but requested data from the teachers or used information from the course. Hilliger determines that the teaching staff plays a vital role as a link between these two figures since, on the one hand, it mediates or facilitates the students' learning and, on the other hand, it informs or feeds back the managers' leadership. This does not mean that the student is not placed at the center but that the teacher's action generates a byproduct that ultimately improves the student's learning.

During her professional experience at the Pontifical Catholic University of Chile, Hilliger has worked in an LA subfield called curricular analytics. This subfield, aimed toward education and engineering direction, involves improving programs with several project-based courses based on feedback. She shares some examples, such as the implementation of a survey applied weekly, where each teacher has a visualization of the time students spend on different activities.

The measurement of the perceived academic load in relation to the teaching-learning exercises is a relevant context to consider when designing the subject. The observed time of dedication is usually greater in project-based courses because when people collaborate with real counterparts and generate reports or presentations for them, their responsibility increases. Given this, teachers can have successful conversations with their students well before the end of the semester regarding planning times, avoid arriving very close to the requested deadline, and have the opportunity to decide or advise on their time management.

In the same scenario, she explains that teachers can decide the extent or difficulty of a certain strategy in this type of subject. This way, complexity is adjusted based on the estimated load of the challenge to align it with the student's ability based on their previous performance or knowledge.

Another tool provided by Hilliger is to take the results of students in assessment tactics applied in real contexts and translate them into a competency achievement, thinking about the fulfillment of the graduate profile. Thus, it is possible to make the achievement of skills tangible to the heads of curricula, programs, and teachers so that they can discuss continuous improvement actions in instructional design or evaluation strategies.

"To strengthen the teachers, we must think of initiatives that have to do with processes that demand a certain load and lower it based on elements that teachers seek to improve, such as the delivery of feedback or instructional decision-making. It is relevant to make them part of the process and look for those aspects and critical moments when they need information to improve their instruction."

- Isabel Hilliger, Assistant Professor and Deputy Director of Measurement, Evaluation, and Quality at the School of Engineering of the Pontifical Catholic University of Chile

Castañeda Garza adds that teacher training in LA is essential since, in some cases, the approach to solving problems lies in integrating a new technology to advance. However, this evolution is not possible without all parties understanding how to use it or how it is useful. Training can take place at different levels; most interventions involve a group of teachers from small institutions or departments at a micro level.

However, he suggests that some challenges persist when deploying technology resources within the classroom. For example, if teachers do not have a notion about how data is processed, how it is used, and how it gets into their hands, they cannot progress. Teachers must at least have an understanding of computer science, statistics, and educational evaluation. Therefore, the main goal is to strengthen teachers with data literacy.

He also explains that it is advisable to carry out pilot projects to solve problems in small steps and to attain certainty that the technologi-

cal instruments work. It is also important to consider teachers' time and availability. In administrative and managerial terms, it is necessary to set aside time for training and understanding all LA topics regarding data, technologies, and ethics.

In turn, Gašević describes that Monash University has a learning and teaching center called Teach HQ, which offers different resources on protocols and procedures of the same institution. In this way, they create an effective community of practice, coming from the professionals themselves and not only from senior managers, who must also be prepared to know the transition from theory to actual application.

Ruiz Ramírez states that institutional support for teachers is crucial in LA issues. For a classroom initiative to make significant progress, follow-up must occur to recognize over time what happens to each student. Castañeda Garza agrees that it is a structural issue, with a strategic management vi-

sion that can contemplate the opinion of teachers and support their needs.

In addition, Morán Mirabal explains that many institutions may have every intention of innovating, although, unfortunately, they do not have the most inspiring or effective dynamics. Therefore, the collaborative aspect is important since, by making interdisciplinary connections, the depth of impact of interesting exercises is even greater.

Magana adds that some current educational institutions provide professional development workshops or personalized consultations to teachers to understand their needs and guide them in adopting new technologies. In addition, the faculty may reach out to professional societies and educational conferences that offer learning opportunities. There are also journals specializing in education research that share educational innovations and report their results and evaluations.

Instruments emerging from LA should mediate dialogue between teachers and students, not replace them, strengthening a relationship that ultimately translates into better educational outcomes.

"Any technology can be supportive to both the instructor and the student, but it cannot be replaced. There are social, cultural, and emotional aspects that are important and necessary for the training of students that cannot be provided by technology."

- Alejandra Magana, Associate Professor of Computing and Information Technology and Engineering Education at Purdue University

Hilliger also highlights the collaboration among individuals involved in the Learning Analytics to Improve Higher Education in Latin America (LALA) project from Toulouse University in France, César School in Brazil, and the Pontifical Catholic University of Chile. This project is based on LA to improve feedback delivery. It has been working on identifying indicators that the students and faculty value based on their actionability and ease of interpretation.

Ceballos Cancino adds that a notable topic in the surveys he carried out previously is that students expect appropriate feedback from the faculty. However, the latter often has to review fifty writing assignments, which isn't an easy task. Therefore, there are strategies to speed up the review of this type of work, from the most traditional ones that use standardized questions and identify keywords in the answer for assessment to the generation of automatic summaries using ChatGPT. In this sense,

generative AI tools can be an excellent support for the teacher.

All these resources can be applied to provide distance tutoring to students. For example, he explains that there are works in progress on how to be smart tutors. This way, the teacher would collect all the material relevant to their class and deliver it to a generative AI, and the technology would generate questions for a questionnaire or be trained to answer questions from the student body. Thus, there is a constant "tutor" while specific details are discussed with teachers, which also eases and redefines their responsibilities in the classroom.

"Currently, there are means to strengthen teachers so that, with the data they can collect from their students, they can take action and not just stay in what they could have done if they had had information."

- Hector Ceballos Cancino, Director
of the IFE Living Lab & Data Hub

g. Ethical Aspects

Different technologies are used within the field of LA, so concerns arise among specialists and actors in the educational field regarding the privacy and ethical management of student data. Capturing this information requires careful processing, as it corresponds to personal data, says Morán Mirabal.

He also states that it is a complex issue since the devices applied capture figures in various ways. Some involve video or audio collection, but others also record physiological data and analyze a person's neural activity. He adds that some experimental protocols should detail the technologies used, the information being collected, and the secure treatment of data, and explain how the technologies are not invasive to participants.

> **Hilliger points out that for data protection, there are three aspects to take into account:**
>
> Existing research on LA ethics needs to be considered. We should understand the origins of the ethical codes and take a consequentialist approach, aiming to maximize learning improvement and prevent abandonment while also considering potential risks and damages related to personal protection. There are already written codes and an academic discussion that can feed a dialogue at the institutional level from the perception of the organization's own educational actors, including managers, teachers, and students.
>
> The regulations or legal framework are in accordance with the Personal Data Protection Law established by each country's Constitution. This governs the educational institution in some way, but it is limited to a legal context. Regardless of what is desirable from the actors or the investigation in LA, it is essential to comply with that legal framework and to establish how it is operationalized.
>
> Certain capacities or regulations exist at the institutional level; however, in the community, there may be other organizations with different preferences. Considering the rapid evolution of technologies, it is possible that techniques that could not be implemented before may be established.

As an example, the IFE Living Lab makes sure to clarify, through a letter of informed consent, that the records collected will eventually be translated into numerical indicators. If data points can be traced back to the participant, they are subsequently deleted. From this, the team builds databases of data collections, where the information is depersonalized.

Alvarado Uribe points out that one way to transmit information is through an anonymization methodology, where the data is transformed so as not to disclose its original form. For example, in the face of a student's response explaining how they feel about a specific situation in an interview, instead of propagating their textual response, the emotional state is captured (if their impression is positive, negative, neutral, or sad, among others). In this way, the information continues to be useful

for understanding how students feel while protecting the sensitivity of their data.

At the IFE Data Hub, privacy notices are used. They include the consent that students give when entering the university and the purposes of the research. The previously signed terms of use documents notify that no lucrative purpose is sought and that the data are fully analytical in nature. There is also no access to tuition, and only specific figures are observed, avoiding some, such as those relating to salaries. Some data is masked or anonymized by ranges so as not to provide direct information.

Another of Morán Mirabal's recommendations is Tecnológico de Monterrey's exercise of having an ethics committee composed of personnel from different departments. The committee is responsible for studying the types of projects and their purposes concerning different subjects.

He also describes that there is a great challenge in the application since the sensors of today's technologies are more ubiquitous. He believes that it is important to plan how to integrate instruments into an actual classroom that can capture data. It is essential to also establish how security protocols will be implemented, how data will be collected and stored, and who will have access to the information, among other details.

"Ethics are in place at all times, from the project planning to its implementation, analysis, and publication."

- Jessica Alejandra Ruiz Ramírez, Experiential Research Coordinator at the IFE Living Lab

Magana says technology is moving faster than governance. Fortunately, however, there are some sources of reference and codes of ethics that guide the use of LA to maintain the privacy and confidentiality of students. For example, she shares that the [Belmont Report](#) identifies fundamental ethical principles for conducting human studies. Also, the [Common Rule](#) and the [Declaration of Helsinki](#) include descriptions of how to protect participants in different types of research studies. These expectations or guidelines can be used for the implementation of LA.

Meanwhile, Alvarado Uribe argues that regulations are a latent challenge within this area. She adds that European regulations, some of which belong to Canada and the U.S., determine accurate levels of risk for AI-based systems, which are relevant as a benchmark for using technologies with students. Therefore, a data consortium would be helpful to address some of the main concerns. An example is data sharing, given that some institutions do not even have a system to analyze or store their information and do not know what data can be disclosed. At the level of each organization or country, it would be helpful to define what data is considered sensitive or personal and thus share only relevant content.

Likewise, she explains that Tecnológico de Monterrey regulates information through data governance statutes, a relevant area that double-validates the figures provided. The area carries out an audit of the dictionaries used, which contain the variables, their descriptions, and data values to assess which are sensitive based on specific regulations and determine what to do to mask the data. It should be mentioned that when students are minors, there must be the consent of the parents or guardians.

Hilliger denotes that, in the long run, it is vital that, beyond establishing a regulatory framework based on previous experiences, academically or legally, there should be a constant review that ensures its own continuous improvement, considering that both technology and people's perceptions change.

As a result, preferences on consent, access, or transparency may also change over time.

On the other hand, regarding the ethical aspects of implementation, Ceballos Cancino recommends that a model that predicts that some students will drop out cannot be applied during admission but once the student enters. Otherwise, the models may be biased or discriminate against students with probabilities of good results, but who, because an algorithm determined their future, are denied the opportunity to enter the institution.

Ethical issues, like the previous example, help us understand that it is necessary to address urgent matters, such as the current furor of generative AI, as well as important matters. Therefore, it is vital to develop practices and strategies that protect students' rights and guarantee equity so that the benefits of LA do not compromise the ethical principles of education.

Future Remarks

LA in academia makes an effort to support transforming the way we teach and learn. LA's optimization and customization offer provides better educational results and contributes to glimpsing a comprehensive picture through technological resources, hand in hand with active and effective pedagogies.

According to Castañeda Garza, the future of this field will inevitably involve contemplating the vision of why to use these technological resources. A tool should not be implemented just for novelty; it should involve thinking about prevention and observing how those involved will benefit or be affected. Ceballos Cancino agrees that LA helps to evaluate the impact and significance of any technology, assessing whether it remains in use or is forgotten. He stresses that this is a great virtue when making these types of measurements, especially when adapting to emerging trends.

LA is the equivalent of learning about students who were previously unsuccessful, says Ryan Baker. He mentions that today there is a variety of data to be detected, which opens up extensive opportunities to adapt learning to people and add improvements, identifying what works on a small or large scale. There are no magic solutions, but there is the potential to formulate small tune-ups that eventually translate into big changes.

Gašević states that a bright future awaits LA, remaining as a discipline that will be relevant and paramount to measuring and understanding how learning occurs in contexts that experience constant renewals.

"Learning Analytics is actually there, offering us far more reliable accounts of how certain things are done."

- Dragan Gašević, Analyst and Professor of Learning Analytics at Monash University

As technology progresses, teachers gain experience managing LA with timely and refined feedback mechanisms. Thus, learning is personalized, with responses based not only on past actions but also on emotional and mental conditions, taking into account the unique cognitive profiles and specific trajectories of each student.[20]

Similarly, LA systems will be able to combine data from various sources and perceive interactions among students, providing a complete picture of each individual's learning and creating collaborative environments. Also,[21] in the future, these systems may become accessible not only to institutions but also to private teachers and students, democratizing their use through open-source platforms and projects promoted by the LA community.

20 Sharif, H. and Atif, A. (2024).The Evolving Classroom: How Learning Analytics Is Shaping the Future of Education and Feedback Mechanisms. *Education Sciences, 14*(2). https://doi.org/10.3390/educsci14020176

21 Ibid.

For her part, Echeverría points out that LA is shaping up toward a continuous adaptation to emerging technologies, such as generative AI and virtual and augmented reality. These tools will be increasingly integrated into the educational environment to improve students' understanding of the learning process. However, they face the challenge of not becoming a barrier to the development of critical thinking since accessibility to information can diminish this ability. Despite these challenges, LA will evolve to accompany students in using and adapting to the emerging technologies they manage throughout their educational process.

The future landscape is an interconnected, personalized, and responsive educational ecosystem where education is marked by innovation and diversity.[22]

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22 Ibid.

Conclusion

Technological advances will continue to come and evolve to provide a range of offerings that promise to be essential. That said, even if we want all the latest technologies, we will always need to take a small step back to contemplate the full picture of an institution's current context before integrating them.

For the adoption of new technologies, educational entities will have to constantly update themselves to understand them and begin a process that starts by identifying the relationship between the technology's usefulness and the school's objectives, followed by designing an action plan to incorporate the technology into the classroom, execute it and evaluate it. All in order to have a positive impact that enriches the experience of the institutional community and that is very useful for the future that graduates will face.

Considering the obstacles and challenges that the application of LA brings, this report shows that the risk of executing these technologies well is worth it. However, the presence of a leader with a vision that always keeps the institution's goals and values in mind will be key to a successful implementation.

Transparency in any action taken by an institution is essential. However, LA can only be successfully integrated if this virtue is considered. The data of the institution's members is invaluable and must be treated as such, using it appropriately and ethically. However, first, there must be transparency in the actions followed to process it, thus strengthening the academic experiences of all parties involved.

"The same initiatives that are implemented have to anticipate how they are transparent to educational actors, how their integration or adoption actually contributes to the educational teaching process, and how it improves expected learnings. There will be more knowledge and research, not only academic but also at the institutional level, but with that comes greater responsibility to know if it has been effectively improved. In turn, the promises made with the creation of this line of work must be delivered to students, teachers, and managers."

- Isabel Hilliger, Assistant Professor and Deputy Director of Measurement, Evaluation, and Quality at the School of Engineering of the Pontifical Catholic University of Chile

LA has proven to be one of the most introspective technologies of the time. It transforms education and provides a wealth of information that would have been very difficult or even impossible to collect in past times. Examining each individual's data can lead to effective, inclusive decisions that greatly benefit the present and future well-being of an entire institutional community.

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