

Analytics in Education Insights and Applications from Latin America

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Abstract– *The expansion of digital technologies and persistent educational inequalities have turned data into a strategic resource for Latin American education systems. However, the use of educational analytics remains uneven, shaped by differences in connectivity, institutional capacity, data governance, and teacher preparation. This article examines how educational analytics, particularly Learning Analytics, is being adopted in Latin America and under what conditions it can support quality, equity, and institutional decision-making. The study combines a narrative review of recent literature with descriptive analysis of official connectivity indicators for selected countries. Findings show a growing but fragmented landscape of dashboards, early warning systems, predictive models, and advising tools, concentrated mainly in institutions with stronger digital and research capacities. The paper argues that analytics should be understood as a socio-technical system in which infrastructure, governance, professional interpretation, and institutional action interact. It concludes by proposing design principles for context-sensitive analytics that align data use with educational improvement, ethical safeguards, and institutional objectives.*

Keywords– *Educational analytics, Latin America, Data-driven education, Student engagement.*

I. INTRODUCTION

The last 10 years have seen a significant transformation within an educational system across the globe and has provided educators around the globe with access to a wealth of information using digital data. The creation of virtual learning environments, student information systems, institutional platforms, and open online resources provide an abundance of digital traces from which educators can glean teaching and learning behaviors. The collection and analysis of these digital traces allow educators to leverage healthcare and educational data science to identify education system problem areas, monitor progress and design better learning interventions. Learning analytics is an area that was created to explore the intersection of educational research, data science and the design of sociotechnical systems that support a learner-centered learning environment.

Aside from the global trends impacting Latin America, these intersect with a much more complex regional context than one would encounter in other parts of the world. Most Latin American nations have experienced increased access to both primary and secondary education; however, enrolment in higher education has been rising significantly in the region. There are still considerable gaps between the quality of

education offered in different countries in Latin America, high levels of drop-out rates, and ongoing socioeconomic inequities. Several international organizations including the World Bank, OECD and United Nations Educational, Scientific and Cultural Organization (UNESCO), have expressed a need to address a “dual challenge” facing Latin America: maintaining educational access and improving the quality of learning and decreasing economic inequalities. Therefore, the potential for using analytic tools may provide an opportunity to improve system transparency and early identification of risks and begin to distribute limited resources more effectively.

The success of educational analytics does not happen in a vacuum. For educational analytics to be successfully adopted, there must be a robust digital infrastructure available; there must also be an interoperable information system and a well-defined regulatory framework, but perhaps the most important requirement is having the ability to interpret and use evidence in a pedagogically meaningful manner by educational institutions and professionals. The landscape of Latin America is marked with its internal diversity (e.g., some universities/systems have well-developed data warehousing systems and have significant experience using data for quality assurance; however, in other areas where there is a lack of basic connectivity or where there are fragmented data sources, this data may be difficult to obtain). The ongoing digitalization of education in the region points to the fact that many Latin Americans still lack access to the internet or must rely on poor-quality internet, and thus the way that the region interacts with and utilizes data in developing data-driven educational strategies remains complex.

Latin America is currently experiencing educational challenges as part of a larger society. In recent years schools have experienced pressure to create measurable results based upon some form of evidence. For example, examples of accountability pressures include the use of reporting to the local office of the district or state (via standardized testing), rankings, performance evaluation systems and so on. The emergence of educational analytics can thus be seen as a new type of managerially based tools, much like the historical emergence of tools used in public administrative management, the financial sector and banking. Corporate governance indices, risk management practices in banks, and the relationship between reputation and corporate responsibility have been studied by various banks throughout Latin America. As a result, using data analytics for accountability within banking creates ways of changing or new opportunities for improving both decision-making by leadership and stakeholder accountability for corporations. Ultimately, while the financial sector provides the

basis for this discussion on improvements in corporate governance, risk management and stakeholder accountability through data, the principles and/or concepts explored have many applications within educational systems as well as other sectors experiencing similar types of pressure.

In response to the above situation, there has been an increase in research examining learning analytics. A considerable amount of research has been conducted demonstrating how institutions of higher education throughout Latin America (specifically Brazil, Chile, Colombia, Ecuador, Mexico, and Uruguay) have established projects that utilize dashboard systems, early warning systems, prediction models and data analytics supported advising. Using virtual classroom data, enrolment history and assessment data, the above research has provided educators, students and institutional managers with resources to perform their jobs effectively. The editorial and systematic reviews produced by scholars in the field of learning analytics have highlighted that the use of learning analytics in Latin America presents a paradox, as the region is known to be a creative as well as difficult environment in which to conduct learning analytics research due to the juxtaposition of innovative pilot programs operating against a backdrop of extremely unequal social conditions.

Although progress has been made in EPID, analytics in Latin America have not yet been synthesized into one cohesive view at the systemic, institutional and classroom levels. Most of the published literature reflects one of the following: either case study methodology on specific instances or reflective, policy and ethical perspectives. More comprehensive analyses should merge the regional digital divide, governance of institutions, pedagogical practices in the classrooms, and the actual experiences of students and educators. Additionally, lessons learnt from the banking and corporate governing sectors, which now have developed advanced methods of using data for decision making, should be incorporated into the current education system. In this paper, educational analytics systems are understood with a socio-technical framework, since analytics systems are composed of interacting technical, institutional, and human elements. The value of analytics comes from the way these elements are connected and translated into institutional and pedagogical action.

The objective of this paper is to provide information about the state of educational analytics in Latin America. To this end, the article combines an overview (narrative review) of the empirical and conceptual literature on learning analytics, along with a description of the qualitative and quantitative research conducted about digital connectivity throughout the region. To do this, the article poses three main questions that helped guide the structure of the paper. The first question addresses how current research around learning analytics is conceptualized and the way it is being developed. The second question addresses what trends have emerged from the development and implementation of analytics initiatives within the context of colleges/universities, institutional educational systems, and how they are being governed. The third question addresses

whether analytics will help create more equitable and contextualized educational practices or merely serve as a tool to reinforce historical systems of inequality.

The literature review section explores how Learning Analytics has progressed and highlights significant contributions to Latin America through its growth and development. Methodology outlines the procedures employed while conducting the literature review as well as detailing which official/statistical databases created this data. Results/discuss include both interpretive and empirical data derived from the research conducted, providing an overview of Learning Analytics opportunities, weaknesses, etc.; Table and Figure depict these elements along with proposed solutions based upon a visual representation of regions with connectivity metrics; Conclusions offer policy implications as they relate to educational analytics into Latin America.

II. LITERATURE REVIEW

Learning analytics refers to the use of data generated by learners and their contexts. To put it simply, learning analytics is a discipline that uses data generated during the learning process to better understand how we can better support our students. This includes identifying ways of supporting students and their learning in real time, as well as utilizing the data generated from learning environments to create effective instructional plans for teachers and students. As a result, this field of study has expanded beyond simply determining the best ways to use the data from learning environments to provide real-time feedback to students, to include all aspects of learning analytics, such as ethical considerations, governance, equity and inclusivity, and the relationship between learning analytics and other theories of learning today. An international review of the literature indicates that the major emphasis in the field of learning analytics today is still on how to use this discipline to enhance the educational experience in postsecondary educational institutions, particularly in the areas of fully online and blended learning environments, as well as the most significant amount of research completed today focuses on the technical aspects (i.e. modelling, prediction, etc.) of learning analytics rather than long-term pedagogical transformation.

The increasing globalization of learning analytics suggests that we are seeing numerous options being created for universities (University of Pennsylvania) around the world to respond to demand, enhance their value proposition to customers and generate revenue streams. In addition to the Journal of Learning Analytics, we are witnessing the growing recognition of several leading conferences focusing exclusively on learning analytics. As learning analytics continues to evolve and expand to reach more stakeholders in the higher education sector, the challenge will be for institutions to develop partnerships with educators as co-designers instead of just being users of tools [1]. Ferguson et al. explores the increasing number of experts who express their concerns regarding the future of learning analytics as it relates to ethical implications, reliance on evidence, and alignment/collaboration with

institutional strategies. Authors explore how learning analytics can provide personalized instructional options, identify at-risk students and evaluate the effectiveness of particular learning designs, and while these studies represent early-stage potential, there have been significant concerns raised about the lack of transparency of algorithms used in the evaluation and the potential to reinforce existing bias [2].

Latin America is an increasingly dynamic area within a World context. In fact, a special issue published in 2020 by the British Journal of Educational Technology, entitled “Latin America: Emerging Applications of Learning Analytics,” contained a selection of research articles, conceptual editorials, case studies at national levels and institutional dashboard examples, as well as classroom interventions, associated with learning analytics and educational technology in Latin America [3][4]. Mapping studies based on comprehensive literature reviews and conducting systematic searches for articles related to learning analytics demonstrate a rapidly growing number of projects and initiatives in this region. Although the initial concentration of these projects was primarily in Brazil, Mexico, Chile and Uruguay, the number and scope of projects is rapidly increasing with the inclusion of other countries contributing to the collective body of knowledge. According to Cechinel et al., many of these projects have multiple layers of data collection, including those utilized to monitor student performance nationally and those utilized to track student engagement and academic achievement on the web [5]. In light of the local context(s), as evidenced by these studies, it is clear that Latin America is not merely importing learning analytics concepts/models from other parts of the World; rather, it is utilizing these models to create solutions that are uniquely appropriate to the complex educational systems in place, often working with heterogeneous infrastructure and regulatory contexts.

Other research in this area has looked at how institutions will need to evolve their policies and support systems so that learning analytics become embedded in their working environments. Hilliger et al., for example, looked at IT resource issues across multiple Latin-American universities (by way of focus group and survey data), and were able to determine that these universities typically do not have established governance structures regarding technology, fully integrated management information systems, nor developed, strategically integrated frameworks for using data in a manner that supports both teaching and learning [6]. Several additional complementary case studies are focused on the ways in which institutions and faculty are integrating learning analytics tools into support structures for advisor-student dialogues, strengthening academic support services, and using analytics to enhance introductory programming courses (specifically) in the Brazilian Amazon region. Together, these studies demonstrate that, in order for a given institution's learning analytics initiatives to be successful, there must be an alignment between the design of the technology, the culture of the institution, and the actual day to day practices of educators using the system.

Many ethical and political issues also arise from literature. Ferguson and others highlight the importance of designing and deploying learning analytics with careful consideration of consent, transparency, accountability, and the risk of surveillance. Studies from Latin America have similar themes and provide evidence that there needs to be development of local regulatory frameworks that support the protection of privacy while using data for legitimate educational purposes [4], [7]. In several of the initiatives noted in the regional literature, ethics committees, stakeholder consultation processes, and explicit policies regarding data retention, access and sharing have been intentionally included. The design of analytics systems should be seen as an opportunity to foster a culture of responsible use of data and not simply as a technical process.

The emergence of learning analytics, the application of artificial intelligence to educational practices and learning (AI in education) and teacher preparation have drawn greater interest. Salas Pilco et al. (2018) conducted a systematic review on the integration of AI and learning analytics into teacher training, which concluded that while there is limited empirical research on this topic, AI and learning analytics can facilitate the growth of digital competency, reflective practice and evidence-based pedagogy through careful implementation. In Latin America, where many teachers have large workloads, limited access to professional development and considerable pressure from the government to achieve better student learning results, the work surrounding this project is particularly important. Analytics can reveal student behaviors that may not have been evident to teachers without the ability to interpret analytical information based on the teachers' own pedagogical objectives as well as the specific context in which they are working.

Many studies have been done to look into how digitalization impacts the education of students throughout Latin America. The studies indicate that there is significant inequality when it comes to access to broadband internet, computers and digital literacy across Latin America. Studies from both ECLAC (the Economic Commission for Latin America and the Caribbean) and The World Bank show that while internet usage and availability have increased dramatically, there is still a large discrepancy between urban vs. rural, affluent vs. low income and between countries in Latin America. Because of these disparities, some students may not have an opportunity to learn through online digital platforms and as a result, their data may not be included in future analytics. Therefore, analytics cannot assist in promoting equity for students, unless the entire population of students uses the digital tools to provide the underlying data that will be analyzed.

While developing a map of educational analytics for Latin America using the available literature, many of the disciplines and methods, as well as practical examples of analyses, have emerged from global research (i.e. international debates). In addition to these examples, there is a great deal of literature that

explains how to create a robust evidence base upon which to build analytic capabilities in a particular region (i.e. how do you make analytics work within an existing historical, institutional and policy framework). Furthermore, many of the discussions within the literature indicate that there is a common understanding that educational analytics are not neutral tools but have embedded within them underlying values about what is considered valuable learning, what the priority outcomes are, and what dimensions of educational experience are seen as the legitimate objects of measurement. Thus, the next sections will outline how this research links back to the existing body of knowledge on educational analytics in the Latin American context. The final sections will also provide an overview of how this research was undertaken within the frameworks of Latin American educational systems.

III. METHODOLOGY

This paper uses a narrative literature review combined with the illustrative analysis of secondary data. Selecting a narrative literature review is most appropriate because it allows an integrated approach to the large number of different types of documents being researched, such as empirical case studies, systematic literature reviews and concept papers, as well as official statistics and policy documents. Instead of aiming to construct an exhaustive listing of all published articles related to learning analytics, the aim of this narrative literature review is to identify key themes, contradictions and lacunae in relation to understanding the Latin American context.

The literature search covered publications from 2010 to 2024, with emphasis on articles published from 2018 onward, as the field continues to mature and develop newer types of technologies; additionally, there is a need for current "best practices" based upon the use of recent evidence. The objective was to synthesize the main empirical, conceptual, and policy-oriented contributions that help explain the development of educational analytics in the region. The search process followed three stages. First, academic databases including Scopus, Web of Science, ERIC, ScienceDirect, Google Scholar, SciELO, and Redalyc were searched using combinations of the following terms: "learning analytics," "educational analytics," "Latin America," "higher education," "data governance," "early warning systems," "student dashboards," "predictive models," "teacher education," "digital inequality," and "educational technology." Searches were conducted primarily in English, with selected searches in Spanish and Portuguese to capture regional publications.

The reference list from these identified key articles were further reviewed for any related articles not discovered through the previous searches, with special attention placed on two special issues; the special issue published in 2020 regarding learning analytics in Latin America, and also the special issue published in 2024 on the application of learning analytics to Latin America.

The initial search results were screened by title, abstract, and relevance to the Latin American context. Priority was given

to peer-reviewed articles, special issues, systematic or mapping reviews, and empirical studies reporting on applications of analytics initiatives in educational institutions. Studies were included when they addressed at least one of the following: Learning Analytics adoption in Latin America, educational data governance, digital infrastructure and connectivity, institutional decision-making, teacher or student engagement with analytics, or equity and ethical issues. Studies were excluded when they focused exclusively on technical modelling without connection to educational use, when they addressed regions outside Latin America without transferable conceptual relevance, or when they did not provide sufficient information about the educational context. Finally, several studies related to corporate governance, risk management and corporate social responsibility were consulted to draw parallels and obtain meaningful insights related to using data-driven decisions and accountability in education.

The analysis was carried out in a cyclical and interpretative way. The selected literature was organized thematically rather than statistically. The analysis focused on identifying recurring patterns, tensions, and gaps across the literature. Particular attention was given to whether studies emphasized technical performance, institutional governance, pedagogical use, or equity implications. The creation of these categories provided the framework that was used when reading the remaining documents and coding those documents' significant quotes. Careful consideration was given to the different studies' position on the application of analytics to the broader issues of educational quality, digital equity and transformation, as well as their representations of the facilitating and limiting factors regarding the implementation of learning analytics at all three (i.e., system, institutional and classroom levels).

To augment the literature review, a secondary source of data regarding digital connectivity, specifically the percentage of people that access the Internet and the growth of broadband service in selected Latin American nations were utilized. Since access was limited to some of the interactive databases, an analysis of published data based on Peer-reviewed articles and agency reports, primarily those published by the international telecommunication union will serve as the basis of analysis. Additionally, several other various regional digitalization studies have synthesized values reported within them into a table displaying connectivity trends for Brazil, Chile, Colombia and Mexico from 2010 to 2017 (which coincides with the emergence of virtual learning solutions and early educational analytics initiatives). The values are presented as a non-exhaustive set of indicators intended to illustrate the structural conditions under which educational analytics developed.

Finally, selected literature on governance and risk management was used as a conceptual reference to interpret educational analytics as a decision-support system that requires transparency, accountability, and risk controls. This comparison is done as a supporting lens for discussing data governance in educational institutions.

IV. RESULTS AND DISCUSSION

A. Structural conditions for educational analytics in Latin America

A first finding from the research is that Educational Analytics initiatives occur under structural constraints created by severe imbalances in levels of connectivity and digital infrastructure in the region of Latin America. Research analyzing the diffusion of ICTs in this region indicates that the amount of internet users has greatly increased over the past ten years yet there is still a significant degree of disparity in internet access both geographically across countries and socioeconomically within countries. For example, research based on data from the International Telecommunication Union shows that approximately 75 % of the region's population had become internet users by early 2020, however, most internet users in the region are concentrated in urban areas and in the more connected countries of the region.

There are important structural implications for the way education analytics and educational data systems are developed today that create a disconnect between different groups of students. For many students, there is a lack of reliable and consistent connectivity to the Internet due to reliance on shared devices (many times for an entire cohort), prepaid data plans and/or limited access to broadband services. As a result, the data that these students generate from their digital learning will be very limited and not representative of all students who engage with digital learning. Educational analytics systems that rely on consistent, stable virtual (online) learning environments and continuously log student activity will therefore likely minimize the experiences of the most at-risk or disadvantaged learners, thereby perpetuating the very disparities that the original intent of education analytics sought to diminish. Policymakers in Latin America have been encouraged to include connectivity, access to devices and digital skills as foundational prerequisites to the implementation of any serious education analytics initiative and not treat each element separately.

TABLE 1
INDIVIDUALS USING THE INTERNET IN SELECTED LATIN AMERICAN COUNTRIES (% OF POPULATION, 2010 AND 2017)

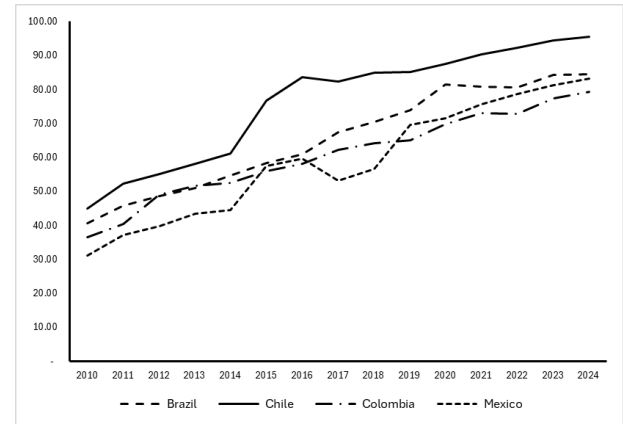
Country	2010 (%)	2017 (%)	Source
Brazil	41	67.5	ITU data reported in Califano and Becerra (2021) [8]
Chile	45	82.3	
Colombia	n.a.	62.3	
Mexico	n.a.	63.9	

Table 1, based on Califano & Becerra, remains useful as a pre-pandemic benchmark of internet access in selected Latin American countries [8]. Their findings show that by 2017 internet use had already increased substantially in countries such as Chile (82.3%) and Brazil (67.5%), while Colombia and Mexico also showed improvement in levels of connectivity. This earlier snapshot reveals the structural conditions under

which the first wave of Learning Analytics development in the region emerged. However, these figures do not fully capture the transformation in digital infrastructure and online learning adoption that took place after the COVID-19 pandemic.

Figure 1 presents updated ITU data on the evolution of internet use in Brazil, Chile, Colombia, and Mexico from 2010 to 2024.

FIGURE 1
EVOLUTION OF INTERNET USE IN SELECTED LATIN AMERICAN COUNTRIES, 2010–2024 (% OF POPULATION) (ITU)



Source: ITU

The figure shows a clear increase in connectivity across all four countries, but its most important contribution is that it captures the acceleration associated with the pandemic and post-pandemic period. While internet access had already expanded substantially before 2017, the shift toward emergency remote education, online services, and digital platforms after 2020 intensified the role of connectivity as a structural condition for educational analytics. By 2024, all four countries had reached levels above 79% of the population using the internet, with Chile approaching near-universal access and Brazil, Colombia, and Mexico showing continued gains. This trend suggests that the infrastructure base for Learning Analytics has become broader than in the period described by Califano and Becerra, although persistent territorial and socioeconomic gaps continue to affect the completeness and representativeness of educational data.

These connectivity trends must be read within a broader Latin American context shaped by structural inequality, uneven institutional capacity, and persistent gaps in digital infrastructure. Although Learning Analytics initiatives have expanded in the region, mapping studies show that they remain fragmented and concentrated in a limited number of universities with stronger technological resources and research capacity [5]. These experiences suggest that data-driven approaches can support student success and institutional decision-making, but they also expose the distance between promising pilot projects and scalable implementation. Recent regional reviews highlight that weak data governance, limited faculty training, fragmented information systems, and unequal connectivity continue to

restrict the broader adoption of Learning Analytics across Latin American institutions [9].

B. Patterns of learning analytics adoption in Latin American institutions

The literature review identified a diverse yet identifiable pattern in the level of adoption of Learning Analytics in Latin America by universities and learning systems. The most activity in Learning Analytics appears to be concentrated in higher education. The early adopters have been those universities that have strong research capacities as well as access to international networks (for example, Europe and North America).

Researchers such as Cechinel et al. have identified over 60 instances of Learning Analytics being used to support, for example, the inclusion of dashboards within learning management systems, the creation of predictive models to identify students who may be at risk, the use of recommender systems to support students in finding learning resources, and the inclusion of analytics in curriculum design [5].

Several of the various initiatives of higher education institutions dealing with analytics can be seen as an extension of increasing efforts to improve quality assurance and to respond to the increased demand for accreditation [6]. Hilliger, and colleagues' (2018) research found that most analytics projects in Latin America were situated in areas of their universities that supported research and evaluation related to institutional quality (e.g., Research Office, Quality Assurance Office, Innovation in Education Centre). The results of these analytic projects will be used to support institutional planning, develop assessment strategies for programs, and evaluate graduation rates [6]. The results from many of the analytics projects being developed at these institutions indicated that analytics would be used to better understand student behaviors, and that tools would be used to help decrease the likelihood of students dropping out, which remains an ongoing concern within the higher education system across the region [6]. Dashboards comprising data related to the students' academic performance and engagement in virtual learning, and administrative data will be developed using analytics to identify those students most likely to benefit from additional support, whether through tutoring, financial aid or both.

The focus of some initiatives is limited to the creation of dashboards and feedback systems for students and their advisors/instructors. According to De Laet and colleagues (2011), a Learning Analytics Dashboard facilitates advisor-student conversations based on criteria such as course completion, grades and participation, as this may help create more clearly specified expectations, and to develop a greater degree of shared accountability for the student's academic success. Guerra and colleagues (2012) developed a similar dashboard for three universities in Latin America and noted the value of adapting the system based on local needs, as well as continuing to modify the system based on feedback received from users. The pilots showed that the adapted dashboards were perceived as useful for academic decision-making and advising

tasks, while also demonstrating that successful implementation depends on the degree to which analytics tools are embedded in existing institutional processes. In the Chilean case, the dashboard supported advisors in decisions related to course registration and dropout risk, reducing the time required to access relevant information and strengthening evidence-based advising. The examples provided represent two ways in which Learning Analytics not only have the potential to create opportunities for increased collaboration between students and advisors/instructors but also enable improved communication between decision makers and students over time.

Fourth, numerous initiatives target various curricular barriers, particularly in beginning programming and STEM programs, which have comparatively high dropout rates. Pereira et al. studied the application of learning analytics in a beginner's programming class in the Brazilian Amazon by using data gleaned from an online judging system to discover tendencies in the method students approached solving problems and to help modify instruction based on these trends. These types of studies utilize analytic processes throughout the pedagogical framework for course delivery; they provide real-time feedback and differentiated assistance rather than utilizing the analytics as merely a static statistic presented on institutional dashboards.

While research indicates an increasing interest in institutional development using improved forms of education technology and an expanding base of knowledge regarding these matters, it must also be noted that many educational institutions still face significant obstacles. The lack of an integrated data infrastructure is one such obstacle. As noted in a previous study, [6], many postsecondary institutions may have enrolment data collected from various sources, academic performance data from different sources, learning management system data collected from various sources, and student support service data stored on distinct systems that have limited interoperability. These factors often produce many small, uncoordinated projects developed by individual faculty members, due to the limited availability of human resources and lack of a clearly defined governance system for developing a coordinated data infrastructure, which makes it difficult to develop an effective organizational strategy.

C. Data governance, ethics and institutional culture

There is a consistent theme across global and regional literature on the necessity to create effective data governance frameworks that will support a type of balance between innovation and ethical responsibility. Ferguson et al. emphasize that establishing clear policies for consent, transparency, accountability, and the right of students to know and challenge the use of their data is vital. The various Latin American examples show that there is an increasing recognition of these issues but that the existence of formalized governance structures remain limited. According to [4], many of the data analytics initiatives occurring in Latin America are happening alongside emerging or fragmented regulations concerning data

protection. This can create confusion among leaders of institutions and legal offices about what types of analytics activities are allowed.

Certain institutions have been proactive in taking measures to address ethical issues regarding the collection and use of student data by creating ethics committees, developing data anonymization policies and providing clarifications about who is responsible for collecting/using student data.

Teachers' attitudes towards data literacy are also essential aspects of culture within an educational institution. In a systematic review on learning analytics' role in teacher education, a number of teachers expressed an interest in using data as a tool in their instructional decision making; however, they felt ill-equipped to analyze the information provided by the complex dashboard or predictive models [10]. In a similar vein, the findings of research examining Italian and Chilean initiatives include results that demonstrate the existence of initial excitement among early adopters and exhibiting parallel results from other educational professionals in these countries, whose use of analytics may be perceived as placing an additional burden on their roles or as being an avenue to erode their professional sovereignty. To build trust in the analytics tools developed for teachers and ensure that the information provided is used for pedagogical rather than administrative purposes, it seems imperative that teachers engage in professional development that introduces them to the basic concepts of data interpretation, encourages critical reflection and involves them in the co-design of the tool itself.

The literature suggests that professional development is most effective when it moves beyond one-time technical training and instead treats teachers as interpreters and co-designers of analytics. In this sense, useful models include workshops on basic data interpretation, guided analysis of dashboard outputs using real course cases, collaborative sessions where teachers discuss possible pedagogical responses to student indicators, and iterative feedback cycles in which teachers help adjust the indicators and visualizations used by the system.

D. Evidence of impact and equity considerations

It is difficult to assess the impact of educational analytics since many initiatives differ greatly in terms of scope, maturity, and context. The literature reviewed contains examples of positive results, such as improved retention rates when using early warning system in pilot project settings; enhanced engagement in courses due to the provision of real-time feedback via dashboards; and improved advising conversations through visualization of students' progress toward graduation. However, many studies are based on limited sample sizes, short duration, or quasi-experimental designs. Consequently, it is difficult to generalize the findings. There is a continued need for longitudinal, multi-institutional assessments comparing analytics-informed interventions and their effectiveness with other methods.

In Latin America, equity is particularly important to consider. The authors highlight that if analytics are based on data that is incomplete or biased, they can unintentionally increase inequalities. For example, early warning systems based on the data of students who have stable internet would be expected to identify students with less participation due to the lack of internet connection. In the same way, predictive models that rely on the historical performance of individuals would continue to reinforce the negative effects of the structural disadvantages that result from factors like socio-economic status, gender, ethnicity, and geographical location. To mitigate these risks, we need to develop both technical strategies, including bias detection and fairness-aware modeling, and policy solutions for supporting disenfranchised populations and including stakeholders who have been impacted by the decisions made using analytics in their design process.

The Journal of Learning Analytics has recently published an article stressing the need for agencies to be mindful of aligning analytics with the values associated with education, as well as recognizing students as collaborators in their development of data, instead of just passive data providers. Many Latin American case studies offer an example of the way analytics is being utilized to stimulate dialogue regarding learning methods, managing workload, and achieving emotional wellbeing; in this way, students are encouraged to consider their own information and work in collaboration with their instructors to establish 'shared' targets. In contrast, other uses of analytics tend to focus on using the data primarily for the purpose of identification, comparison and sanctioning. This type of usage often creates distrust among the student body and causes students to develop resistance towards working collaboratively with their instructors.

The distribution of capacity among Institutions also represents a separate dimension of equity; for example, those elite research institutions that are a part of an international network, that have access to significant external funding, as well as dedicated analytics groups are far more likely to be successful in the use and application of analytics than smaller or less well-resourced institutions (i.e., many public universities and teacher-training colleges) that do not have the same opportunities. The development of regional collaboration, open-source tools, and capacity-building initiatives will be critical to ensure that there is currently and will not be a developing digital inequality between Institutions with the capacity to take maximum advantage of the use of analytics, compared to those that have insufficient resources.

E. Lessons from corporate governance and risk management

Like other data-intensive governance systems, educational analytics can be understood as a decision-support system that requires clear rules about indicators, accountability, risk, and stakeholder participation. In the financial sector, governance frameworks are used to define responsibilities, manage information asymmetries, monitor risks, and prevent decisions from being based only on incomplete or misleading indicators

[11]. A similar concern applies to educational analytics: dashboards, early warning systems, and predictive models may improve institutional decision-making, but they can also create new risks if their indicators are poorly designed, opaque, or disconnected from pedagogical purposes.

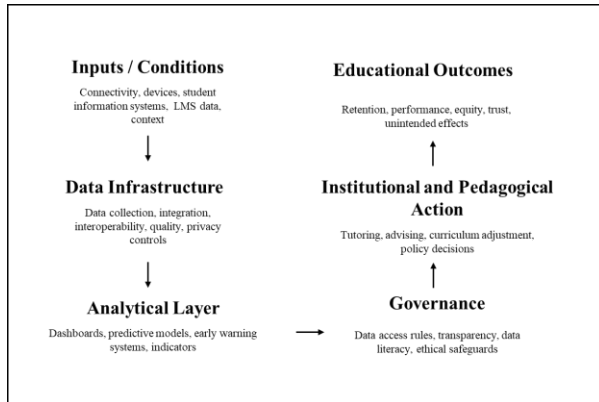
The parallel is presented since analytics systems require governance before they are scaled. In education, this means defining who has access to student data, how indicators are selected, how predictive results are interpreted, and what types of institutional action can legitimately follow from them. For example, an early warning model that identifies dropout risk should be used as a trigger of coordinated response that may include academic advising, psychological assistance, or pedagogical redesign, depending on the causes of risk. Without this type of governance, analytics may reinforce narrow accountability logics rather than support student learning and inclusion.

The governance-risk framework helps clarify that the value of educational analytics depends not only on technical accuracy, but also on the institutional arrangements that translate data into action. For Latin American institutions, where data systems are often fragmented and capacities are uneven, this implies that analytics initiatives should include explicit governance protocols including transparency, privacy and bias policies. These safeguards are especially important if analytics is to move beyond isolated pilots and become part of sustainable institutional decision-making.

F. A socio-technical framework for educational analytics in Latin America

The narrative analysis provides the basis for Figure 2, which presents a socio-technical framework for educational analytics in Latin America.

FIGURE 2
SOCIO-TECHNICAL FRAMEWORK FOR EDUCATIONAL
ANALYTICS IN LATIN AMERICA.



The framework considers educational analytics as a dynamic system rather than a linear process of data collection, modelling, and reporting. The proposed model organizes educational analytics into six connected components: structural conditions shape the data that institutions can collect; data

infrastructure determines the quality and interoperability of that information; analytical tools transform data into indicators; governance and stakeholder interpretation define how those indicators are understood; institutional action translates them into advising, support, curriculum change, or policy decisions; and outcomes should guide future adjustments. Because outcomes produce new data and influence future decisions, the framework should be understood as cyclical rather than linear.

V. CONCLUSIONS

Through an analysis provided within this article, educational analytics within Latin America are currently situated within an area of tension between possibility and limitation. The region has, on one hand, been able to create an array of innovative educational analysis initiatives aimed at improving student achievement, enhancing institutional decision-making as well as spurring educational innovation. By using various dashboards, predictive Models, analytic-driven interventions and so forth, many universities and research organizations throughout Latin America have developed tools to address issues of high dropout rates, low quality and equity concerns specific to their regional settings. Through these efforts, Latin American regions continue to implement creative strategies and demonstrate resiliency despite having limited resources and facing many challenges related to infrastructure.

While the structural conditions that make analytics attractive as tools to improve efficiency and focus support are the same structural conditions that create obstacles to their wider implementation and may impose additional barriers for some institutions. Institutions cannot yet effectively or sustainably implement analytic tools due to the unbalanced availability of broadband access; the disparate nature of current information systems; the low availability of labor with specific training in data analysis, such as business intelligence or statistics; and vague or incomplete regulations. In addition to these technical limitations, all institutions will need to consider the cultural and ethical ramifications associated with analytics. Without appropriate governance and transparency in their operations; the involvement of both teacher and student voices; the establishment of privacy guidelines; and the commitment to equality in the use of analytics, analytics could easily come across as tools used to control and monitor rather than support and enhance learning.

This study argues that educational analytics in Latin America should be understood as a socio-technical assemblage. Its effectiveness depends not only on the availability of data or the accuracy of models, but on the interaction between infrastructure, institutional governance, professional interpretation, student participation, and equity-oriented action. This framing clarifies why analytics initiatives cannot be evaluated only as technical innovations. Data can only be described as having meaning through the multiple processes of collection, processing and interpretation created by institutions, professional cultures and the effect of power relations on the work environment. The process of developing a dashboard,

choosing indicators and developing predictive models all necessarily reflect the creators' beliefs about which aspects of learning are the most important to focus on as indicators of success and how responsibility for learning is distributed between students, teachers and institutions. Understanding that analytics is not a passive object where meaning is placed upon it by data, provides the opportunity to create deliberate design choices that create strong alignment between the data practices and the values of an education system, such as inclusion, critical thinking and democratic participation.

The results of the research reveal important policy directions and considerations for both government and regulatory body. By creating detailed, uniform standards on how to protect student data within an educational setting, as well as providing incentives for the development of interoperable, cross-institutional data infrastructure, governments and regulators can provide essential guidance for the development of analytics in the education sector. Regional collaborations between multiple governments and institutions may allow small, underfunded or under-resourced institutions to gain access to analytics that would otherwise be beyond reach due to a lack of financial resources. Finally, international organizations can continue to provide high-quality, disaggregated data on issues such as connectivity, educational success and socio-economic factors which institutions can then incorporate into their analytics activities.

Schools and universities should regard data analytics at the institution level as one aspect of a larger set of initiatives to achieve either educational improvement or digital transformation, instead of viewing analytical processes as a separate tool. Schools and universities can link existing areas of development to develop meaningful strategies. For that to happen, both technology and human resources must be invested in, including fostering interdisciplinary teams with skills in education, data science, ethics, and governance. Additionally, schools and universities should prioritize developing spaces for dialogue where faculty members and students can have critical discussions regarding the data collected, use this data in conjunction with additional interpretations, and collaboratively create indices that are useful to their specific environment and settings.

Future studies in analytics and its impact in Latin America require additional longitudinal and comparative studies about the long-term impacts of analytics on educational success and outcomes; equity in education; and institutional culture. A mixed method quantitative and qualitative analysis as done with large data sets, while collecting qualitative data from students, teachers, and administrators, will be particularly useful in better understanding all of the different, subtle ways analytics can influence how educational practices are carried out on a daily basis. More opportunities also exist to better understand how analytics intersect with other forms of educational reform, including but not limited to competency-based education, inclusive education, and the globalization of higher education.

At the end of the day, it's not a question of whether educational systems in Latin America will employ analytics, but rather how they will employ analytics and for whom. Data presented in this article suggests that implementing analytics will allow for more timely and well-informed decision-making by school leaders, allow for the identification of students who require additional support, and improve the transparency of institutional performance. However, the authors also warn about the potential for perpetuating or amplifying existing inequities if there isn't an intentional effort to design analytics with a critical lens or to reflect upon the use of those analytics. Therefore, it is critical for policymakers, leaders, educators, and researchers to consider and apply both the analytical potential of data in education as well as the social mission(s) of education for Latin America. Using this balanced approach, educational analytics can create more efficient systems for all students while promoting equity within and among diverse populations in Latin America.

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