VIRTUAL LEARNING ENVIRONMENTS AND *SMART PAPERS* IN LARGE-SCALE ASSESSMENTS

https://doi.org/10.56238/sevened2024.037-032

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ABSTRACT

This article presents the results of the qualitative analysis of the literature on the use of Virtual Learning Environments and *Smart Paper* technology in large-scale evaluations in the Brazilian educational context. The research revealed that virtual learning environments offer tools to make assessments more efficient, although they face challenges such as the need for adequate infrastructure and equity in technological access. On the other hand, *Smart Paper* technology emerges as a promising solution to overcome access and cost obstacles, integrating digital resources into the paper format. It was concluded that these technologies can enrich evaluation practices and support more effective and inclusive educational policies.

Keywords: Large-Scale Evaluation. Virtual Learning Environments. Smart Paper.

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INTRODUCTION

Contemporary education faces challenges and opportunities, both fueled by rapid technological evolution and the need to adapt to increasingly digital learning environments. The information age has brought significant changes to teaching and learning processes, requiring educational systems to constantly reinvent themselves. In this dynamic context, two key elements stand out: large-scale assessments, which make it possible to map performance and identify learning gaps, and virtual learning environments (VLEs), which have the potential to transform the way teachers and students interact, collaborate and build knowledge.

Educational assessments, traditionally conducted in person and analog, have progressively migrated to the digital environment, which creates a fertile field for the use of advanced *learning analytics* tools. These tools allow for detailed analysis of the data collected, offering *insights* into learning patterns, individual and collective performance, as well as suggesting more effective pedagogical interventions. However, the digitization of assessments also poses significant challenges, such as ensuring academic integrity, combating fraud, and creating reliable assessment processes, even in virtualized environments.

However, the growing reliance on digital technologies in education exposes deep inequalities. The digital divide emerges as a critical problem, as unequal access to technology and lack of digital skills among learners can widen already existing educational disparities. More vulnerable regions, where devices, connectivity, and technological capabilities are scarce, face an even greater impact. For many students, the absence of basic resources turns the promise of innovation into another obstacle to educational inclusion.

In this scenario, hybrid solutions that unite elements of digital and traditional have gained prominence. Among these innovations, *Smart Paper* emerges as a promising technology, capable of mitigating part of the barriers imposed by the digital divide. This tool combines the familiarity of paper with the functionality of digital platforms, offering an accessible bridge for students who have difficulty accessing purely digital resources. In addition, *Smart Paper* allows the collection of data in real time, enabling instant analyses that can feed back pedagogical strategies and provide concrete subsidies for more equitable educational policies.

With the implementation of innovative technologies such as *Smart Paper*, there is an opportunity to promote a more inclusive education that meets the needs of different contexts and realities. These tools allow us to expand the scope of assessments and adapt them to the specificities of each group of students, respecting their limitations and potential. In addition, by integrating emerging technologies into assessment practices, it is possible to prepare students to face the challenges of the future, equipping them with competencies that go beyond academic content and include digital skills and critical thinking.

This article aims to shed light on these possibilities by exploring how the convergence between large-scale assessments, virtual learning environments, and hybrid technologies can contribute to a more democratic and effective education. Through a careful analysis of the available tools and their applications, it is expected to open paths for the strategic use of the *insights* generated, which can support proactive, precise educational policies tailored to the specific demands of students in different areas and contexts, ensuring that no one is left behind in the learning process.

METHODOLOGY

The methodology used in this article is based on a qualitative methodological approach, through the analysis of existing literature to deepen the understanding of the implications of digitalization in education, with a specific focus on the convergence of large-scale evaluations and technologies of virtual learning environments and *Smart Paper*. This methodological approach was chosen for its effectiveness in providing a solid foundation for the topics under study, allowing critical analysis, essential for the advancement of educational research in the digital context.

LARGE-SCALE ASSESSMENTS AND VIRTUAL LEARNING ENVIRONMENTS

Education is one of the key elements of social development that reflects the well-being of the country's population and one of the quality of life indicators used to calculate the Human Development Index (HDI), one of the criteria for classifying developed, developing and underdeveloped countries.

Thus, the importance of large-scale evaluations to subsidize public policies in line with the social context, as well as with school practices that articulate curriculum, methodology, evaluation in favor of the quality of education, is emphasized.

Large-scale assessments refer to standardized assessments, whose primary objective is to report results beyond the individual level, aiming to measure the performance of a specific group or population in relation to predefined learning patterns or competencies. These assessments cover a wide range of items and are applied to many students, often on a regional, national, or international scale. They inform areas of improvement in the education system and provide comparative data between different schools, regions or countries.

For Klein and Fontanive (1995, p.30):

> The objectives of the large-scale evaluation of the school system, proposed here, are to inform what populations and subpopulations of students in different grades know and are able to do, at a given time, and to monitor their evolution over the years. It is not your purpose to provide information about individual students or schools.

In these evaluations, it is possible to infer the results of educational progress, at the different levels to provide managers with subsidies for the formulation of educational policies with data that guide the establishment of quality goals, prioritization of actions and allocation of resources.

The Brazilian Constitution of 1988 conceives educational evaluation as a public demand of the State. The Basic Education Evaluation System (Saeb), Prova Brasil, the National High School Exam (Enem) and the National Higher Education Evaluation System (Sinaes) are responsible for different roles:

> 1) To gather information or evidence necessary for the formulation of educational policies, with the purpose of expanding and deepening knowledge about education systems so that the different spheres of government can define intervention priorities; and
> 2) induce changes or consolidate previously structured educational reforms for education systems. (MINHOTO, 2016, p. 78)

In addition to national assessments, there are other international monitoring studies, such as the *Programme for International Student Assessment* (PISA), coordinated and developed by the *Organisation for Economic Cooperation and Development* (OECD) and the Anísio Teixeira Institute for Educational Research (INEP). This world-class program primarily measures the reading, math, and science knowledge and skills of 15-year-old students, the approximate age range for completion of basic education in most participating countries.

In the 2018 edition (Brasil, 2020), the survey analyzed 79 countries, including Brazil, which ranked 57th. Brazil's PISA results (Schleicher, 2019, pp. 6-8), indicate a stagnation in the level of school performance of Brazilian students, with level 2 in reading, level 1 in mathematics and science, on a scale that goes up to 6. The minimum level considered adequate by the *Organisation for Economic Cooperation and Development* (OECD) is 2. In these three areas evaluated, Brazil achieved positions between "58th and 60th place in reading, between 66th and 68th in science, and between 72nd and 74th in mathematics" (Queiroz, 2021, p. 89).

From the analysis of the performance of South American countries in reading, mathematics and science (OECD, 2019, pp. 17-18), the challenging result for Brazil in the list of countries evaluated stands out. With a score of 384 in mathematics, Brazil is ahead only of Argentina (379) and shows a lower performance in relation to other countries, such as Colombia (391), Peru (400), Chile (417) and Uruguay (418), which obtained higher scores in this subject. In terms of reading performance, Brazil (413) is behind Chile (452), Uruguay (427), Colombia (412) and ahead only of Argentina (402) and Peru (401). Leading the group in science, Chile stood out with a score of 444, showing a significant difference between Brazil (404), Argentina (404), Peru (404), Colombia (413), Uruguay (426).

Brazil's performance in this assessment showed that the grades of students in Brazil were among the lowest in the world in the three areas evaluated. In addition, there is a significant disparity in student performance between public schools and private schools. Students enrolled in public schools tend to perform much lower compared to their peers in private schools.

> Internationally, students from private schools tend to perform better in PISA than those from public schools. The difference in performance found in Brazil is, however, particularly large. Public school students in Brazil score below level 2 in reading literacy four times more than private school students (57% versus 13%)3 (OECD, 2021).

This discrepancy can be attributed to a combination of factors, including financial resources available to private schools, more modern infrastructure, smaller class sizes, increased access to educational technology, up-to-date learning materials, and extracurricular programs.

In order to understand the Brazilian educational system in depth in order to direct public policies for the development of education, in 1990 the federal government instituted through Ordinance No. 931 (Brasil, 2005) the National System of Evaluation of Basic Education (SAEB) previously consisting of three large-scale evaluations: National Evaluation of Basic Education (Aneb); National Assessment of School Performance (Anresc), known as Prova Brasil; and National Literacy Assessment (ANA). However, as of 2019, they ceased to exist with this nomenclature, and all these external evaluations were identified as SAEB. Also in this year, the gradual transition to new matrices prepared in accordance with the National Common Curricular Base (BNCC) began, replacing the reference matrices used since 2001.

[3] Trecho Original: Internationally, students in private schools tend to perform better in PISA than those in public schools. The performance gap found in Brazil is however particularly large. Students from public schools in Brazil score below Level 2 on reading literacy over four times more often than students from private schools (57% as opposed to 13%).

The averages of the students' performance scores measured in the SAEB, together with the approval rates calculated in the School Census, make up the Basic Education Development Index (Ideb). This indicator was created in 2007 by the Brazilian federal government to assess the quality of education offered in the country's public schools. It offers subsidies for the elaboration of educational policies and for monitoring the quality goals of the Education Development Plan (PDE) for basic education. Also created in 2007, the PDE (Education Development Plan) is a set of actions and public policies created by the Brazilian federal government in 2007, with the objective of improving the quality of basic education in the country. It is composed of 20 goals that comprise various aspects of education, such as valuing teachers, access to early childhood education, improving school infrastructure, among others.

The Basic Education Evaluation System (Saeb) and the Basic Education Development Index (Ideb) are surveys organized by the National Institute of Educational Studies and Research Anísio Teixeira (Inep), which conducts and disseminates these studies every two years.

Portuguese Language and Mathematics tests are applied in a census form to students from urban and rural public schools in the 5th and 9th grades of Elementary School and 3rd grade of High School. By sampling, students in the 9th grade of Elementary School in some public schools also take tests in Natural Sciences and Human Sciences. Also by sampling, students from the 5th grade, 9th grade EF and 3rd grade of High School from some private schools take Portuguese Language and Mathematics tests and students from the 2nd year of Elementary School from some public and private schools take Portuguese Language and Mathematics tests.

In addition, questionnaires are applied to students, teachers, principals and municipal secretaries of education. These tests are prepared by a team of experts composed of multiple-choice and discursive items, which assess both the knowledge and skills and competencies of the students and use in their construction and application a methodology that allows the evaluation of education networks or systems, and not the students individually as the tests applied by the teachers.

For the analysis of standardized tests, the Item Response Theory (IRT) is used, a complex statistical approach that takes into account not only the number of correct answers, but also the characteristics of each question of the test, assuming that they have a difficulty and discrimination, which may vary according to the characteristics of the group of individuals being evaluated.

> IRT is a set of models where the probability of response to an item is modeled as a function of the student's proficiency (non-observable variable) and parameters (which express certain properties) of the item. The higher the proficiency, the greater the probability that the student will get the item right (KLEIN & FONTANIVE, 1995, p. 31).

Item Response Theory (IRT) is a more recent and advanced approach to the analysis of standardized tests in view of some limitations of Classical Test Theory (TCT), which has been widely used in the educational field, including school assessments and university admission tests. For Soares (2018, p. 38) "the main difference between these theories lies in the fact that the first offers an approach in which the total score of the test is investigated, while in the second, the properties of each item are investigated individually."

One of the main advantages of Classical Test Theory (TCT) is its simplicity to calculate and understand the result of an assessment, in addition to not requiring assumptions for its application in different contexts. However, in this theory, each constructed test has its own scale, as this theory is not able to provide a common scale to compare the performance of individuals in different forms of the test and between different classes of students, such as the Item Response Theory (IRT), unless the conditions of application and correction of the test are strictly standardized and controlled, which is difficult in practice.

Another major difference between the two theories is the ability to identify the students' occasional hits, that is, the kicks (Brasil, 2011). Classical Test Theory (TCT) cannot make this identification. The Item Response Theory (IRT) does not only consider the number of correct answers, but also the difficulty and discrimination of each item of the test (Soares, 2018). It is able to evaluate students fairly and objectively, considering the difficulty of the questions that they got wrong or got right, based on the coherence of their answer pattern, thus pointing out the candidate's real ability in each area of knowledge.

Increasingly used in large-scale international assessments such as the Program for International Student Assessment (PISA), and also in Brazil, such as the National High School Exam (ENEM) and the Basic Education Assessment System (SAEB) (Costa, 2022, p. 46), the Item Response Theory (IRT) has been arousing the interest of educational institutions to subsidize the necessary pedagogical interventions.

In this sense, it should be noted that large-scale assessments in education are taking the direction of computerization in the application of standardized tests, as can already be seen with the implementation of the National High School Exam (ENEM) in digital format, using the same format as traditional tests, but carried out on computers, with consolidation expected by the year 2026, when the application of the printed test will be extinguished (Brasil, 2019, pp. 8-13).

Considering the various advances that this new application format will bring, the possibility of interactive questions of multiple file types and extensions stands out, as well as the possibility of increasing inclusion and accessibility with tests adapted to the needs of people with special needs.

There is already a wide range of technologies with a variety of *online* resources to help teachers and experts assess students according to needs. In this sense, many virtual learning environments are not yet able to assess the full spectrum of skills and competencies that are desired to be developed in students, but this technology can help make assessments more efficient, personalized, and accessible.

With the progress in psychometric research and the development of the capabilities of virtual learning environments, several platforms, including *Moodle*, *Canvas* and *Blackboard*, can also implement Item Response Theory (IRT) through computerized adaptive tests (TAC).

> The Computerized Adaptive Tests, known by the acronym TAC, are basically questionnaires that can be made available in digital media, where the items can be customized and adapted as the student answers them. The TAC make it possible to analyze the student's ability, after the completion of the questionnaire (ORTEGON, 2019, apud ADOLFO, 2021, p. 18)

Unlike traditional tests that are made up of the same questions for all students, adaptive tests are assessments that dynamically adapt to each student's performance during the test, according to their own estimated skill level. If the student answers one question correctly, the next question will be a little more difficult. If he answers incorrectly, the next question will be a little easier. Adaptive tests are common in standardized assessments, but they can also be used in summative and formative assessments.

These environments provide different tools and *plug-ins that allow the creation of IRT-based tests, such as the Adaptive Quiz plugin,* Adaptive Quiz in *Moodle* via R and the *Test Generator* for *Canvas*.

These virtual learning environment tools based on Item Response Theory (IRT) can be customized according to the specific needs of each subject and take into account individual student differences and the characteristics of test items to provide more accurate and equitable assessments.

Although incipient, a broad effort to integrate technology, psychometrics and educational theory has been gaining momentum in the arena of large-scale assessments. This effort seeks to develop more appropriate public policies, employing an evaluation system that can effectively inform about the needs and performance of students, aiming to improve the quality and effectiveness of educational interventions.

VIRTUAL LEARNING ENVIRONMENT AND *LEARNING ANALYTICS TOOLS*

With the emergence of virtual learning environments (VLEs) and the possibility of these systems collecting large volumes of data (*big data*), which can be analyzed to reveal patterns and trends, researchers and education professionals have focused on the development and use of analytical methods to understand and improve learning experiences.

The term *big data* refers to extremely voluminous, complex, and varied data sets that are collected, stored, and processed in order to obtain *insights*, identify patterns, and support informed decision-making. The use of *big data* techniques and technologies makes it possible to analyze and interpret this data to identify trends, patterns, correlations, and *insights* in various areas, such as marketing, health, finance, logistics, science, security, among others.

In the educational context, this data can come from records of activities and performance in tests. The natural transition of this information to more structured practices has led to the development of the field of *Learning Analytics*, a practice centered on the learning process that involves the collection, processing, analysis, and interpretation of large data sets, using statistical and computational techniques of educational data mining and predictive modeling, to understand and improve the teaching and learning process.

The goal of *Learning Analytics* is to "provide data-driven evidence in order to assist teachers and students in improving teaching and learning processes" (Freitas et al., 2020, p. 73). This tool is designed as an extension of the evaluation process, as it allows the teacher to identify the subjects in which students are facing difficulties and based on this information, adjust the content or pace of the classes and provide personalized *feedback* to students.

Siemens and Baker (2012, as cited in Bassani & Cazella, 2021) point to the use of *Learning Analytics* "to provide personalized experiences and align pedagogical strategies in an assertive way for different student profiles". In this sense, this tool can also help identify which evaluative pedagogical practices are succeeding and which need to be adjusted or improved. The main applications of this tool include the identification of learning patterns, student behavior and possibilities for collaboration in the learning environment.

The data mining task can use descriptive, prescriptive, and predictive data modeling. Modeling education data is important because it helps to transform data into useful information that can be used to improve education.

The descriptive model assumes the discovery of interesting patterns or associations between existing data, to provide *insights* into students' performance, identify areas where they need more support, and understand the impact of specific interventions.

In the predictive model, it is possible to "discover patterns and capture relationships in historical and current data, allowing the future projection of a given event" (Filatro, 2021, p. 20). Through parameter-based predictive modeling, it is possible to "predict" the student's behavior (Biagiotti, 2021, p. 71) and performance; their engagement and participation in the evaluation activities; identifying subjects where students had the greatest difficulties and even identifying those who are involved in some type of risk and carrying out intervention to help them achieve success. Through predictive modeling, it is also possible to compare teaching practices to obtain a prediction about the favorable and unfavorable points of each approach.

Prescriptive data models are used to provide recommendations on actions that should be taken to improve student performance. They utilize data analysis to verify pedagogical best practices, as well as recommend interventions for students based on their performance and academic record.

Another field of data mining research is that of explanatory modeling, which seeks to identify interpretable causal relationships between structures that can be observed from collected educational data that could lead to improvements in learning outcomes.

Rosé et al. defendem que:

> [...] explanatory models of the learner, whose objective is to enable a knowledge-oriented use in technology-based education. Learner explanatory models not only provide an accurate prediction, but also offer actionable insights that can better advance both learning science and educational practice.4 (ROSÉ et al., 2019, p. 2944)

This model aims to identify the factors that influence the learning process and student performance. They are built on machine learning algorithms that manipulate data collected from student activity records in virtual environments.

It should be noted that these models must be used carefully and ethically, in order to ensure the security of the student's data.

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[4] Trecho Original: explanatory learner models, the goal of which is to enable insight-driven use of such analytics in technology-enhanced education. Explanatory learner models do not just provide accurate prediction, but also offer actionable insights that may better advance both learning science and educational practice.

The way Learning Analytics data and information is presented can be done through *visual and interactive dashboards that can also be customized according to the needs of teachers and students to monitor their own performance.*

According to Filatro (2021, p. 58), "the construction of *dashboards* is not trivial: identifying what information is relevant and the way to present it so that it is really useful lacks not only technique, but also perception and experimentation very close to the end user."

Student-oriented dashboards are among the most prominent responses to improve their learning experience, encouraging reflection on the relationship between behavior and results obtained, thus contributing to self-regulated learning, allowing the student to take responsibility for their own learning.

AS FERRAMENTAS DE *LEARNING ANALYTICS*

Virtual learning environments can provide a variety of *Learning Analytics tools* to support the task of monitoring student performance and identifying the points that generate the greatest difficulty so that necessary adjustments can be made.

Learning success is not only revealed in students' grades, but also in their learning experiences. When the student uses a virtual learning environment, their actions are recorded, leaving traces that provide important information about the development of the student's learning.

With the information produced, it is possible to:

> [...] understand the progress of students throughout a program, course or discipline, and qualify their interaction with content, tools and people. From this data-based understanding, it is possible to build better pedagogical proposals, enable students to play a proactive role in their learning, identify students at risk, and evaluate factors that affect the completion and success of studies. (FILATRO, 2019, p. 4)

With *Learning Analytics* tools, the teacher can monitor the progress of the class and the student individually, personalize the learning process for each student, identifying their deficiencies and encouraging their improvement, identify in which content students have the most difficulties, enabling the adjustment or complementation of activities or even curricular changes.

Learning Analytics *tools* have some limitations, as information about learner behavior may not reflect an accurate representation of their engagement and learning.

This inference away from the real context can lead to inappropriate conclusions about their behavior and unnecessary interventions. Therefore, it is important that teachers seek to obtain more comprehensive information to understand student behavior in the virtual learning environment. This information can be obtained in a variety of ways, such as direct observation, interactions, reflective activities, group discussions, learning journals, or even through open communications with parents or guardians. This information may include interests, extracurricular activities, life experiences, family issues, or significant events that may affect students' academic performance or emotional well-being.

Most of the reports come from log data on attendance, activity participation, social interactions, course progress, assessment results, resource usage, completion rates, and more.

Learning Analytics *tools* can broaden teachers' horizons for improving evaluation processes. Many still lack a user-friendly and understandable interface, but developers seem to be striving to make them more accessible by applying visualization techniques that may include, but are not limited to, statistical graphs and heat maps to achieve better results.

There are several *Learning Analytics* tools that can differ in terms of functionality and price, and it is necessary to evaluate the teacher's needs for a careful choice of each of them.

Some data analysis tools are already integrated into virtual learning environment platforms, others can be implemented through *plug-ins. In addition, there are still independent data analysis platforms, such as Tableau* and *Power BI,* that can be connected to external data sources. However, in some cases it is necessary to integrate them with the platform to analyze educational data.

Among the free tools available for virtual environment platforms, the following stand out:

- ***Moodle Learning Analytics***

Moodle Learning Analytics is a feature that enables the collection, analysis and interpretation of educational data within the *Moodle* platform, allowing teachers to make informed decisions about student performance in various types of activities and personalise teaching as needed for each student.

It is an open system that allows external developers to create applications and services through the Application Programming Interface (API), *software* that allows different applications to communicate and interact with each other.

As of version 3.4, *Moodle Learning Analytics* has become a native feature of *Moodle*, but it is not enabled by default in all installations, and it is necessary to configure it. In older versions it is necessary to install the *plug-in*.

- ***Quiz Analytics***

The *Quiz Analytics* tool allows the collection of data on students' performance in quizzes. The user can see different graphs depicting metrics such as the number of questions answered correctly and incorrectly, the number of attempts, the time students spend on each question, or the quiz completion rate.

Commercial tools include:

- Intellboard

IntelliBoard is designed to build advanced analytics and reporting on student activity on platforms such as *Moodle*, Canvas, Blackboard, and others.

IntelliBoard collects and interprets data to support the decisions of teachers, instructors, and administrators. It offers real-time monitoring on a single dashboard with graphical data visualizations, as well as report customization options that can track student and teacher activity and performance.

- LearnerScript

LearnerScript is a commercial learning analytics tool that generates various types of custom and interactive reports and charts. It provides access panels with different functionalities for teachers and students. Another important feature is instant communication with students directly from the report, where the teacher can send messages or alerts with *email notification* with important information, deadlines for the delivery of assignments or *personalized feedback*.

Considering the above, it is evident that *Learning Analytics tools, present in virtual learning environments, can contribute significantly to large-scale assessments. By analyzing large volumes of data generated, they provide insights*, facilitating a more detailed understanding of student performance and identifying systemic factors that affect learning. This wealth of information allows us to adopt a more personalized and adaptive approach to assessments, overcoming the limitations of traditional methods, which often fail to address the complexity of the learning process.

In this way, the application of *Learning Analytics* in large-scale assessments can help shape more efficient educational policies, by providing concrete evidence in different contexts and for different groups of students. This allows educators and policymakers to make more informed decisions in order to foster a more inclusive, personalized, and tailored educational environment

ACADEMIC INTEGRITY AND THE FIGHT AGAINST FRAUD IN VIRTUAL LEARNING ENVIRONMENTS

As we advance in the use of virtual learning environments in assessments, the need to address challenges related to academic integrity becomes even more pressing. This is because no system is totally free from fraud in the face of human action, despite continuous efforts to ensure security and fairness in evaluation systems.

Assessment activities in virtual learning environments are fundamentally characterized by a variety of potentially positive factors, but their use needs to be carefully monitored to mitigate risks associated with academic fraud.

While virtual learning environments offer convenience and flexibility to students, allowing them to take assessments at their own times and locations, this same flexibility can create opportunities for dishonest academic practices. The absence of direct oversight during *online assessments* can make it more difficult to detect and prevent fraudulent behavior, such as plagiarism, sharing responses, or unauthorized consultation with external resources.

Therefore, it is necessary to implement effective security and integrity measures in virtual learning environments. Among them, we can highlight real-time monitoring, capturing images and ambient audio to identify suspicious behavior; facial recognition or biometric authentication to ensure that the student is actually the one taking the assessment; access restrictions, blocking the student's access to other resources such as other browser tabs; anti-fraud software that detects suspicious patterns such as reduced time to answer a question or identical answers; randomization of responses among others that are still under development.

In addition, school computer labs can be used to apply online assessments , providing a controlled environment, where it is possible to ensure the security and integrity of the assessment process, minimizing the chances of fraud or misuse of information.

Also, it is important to educate students about the ethical principles of academic integrity and the consequences of dishonest practices, promoting a culture of accountability and honesty in assessments.

Virtual learning environments have control devices that allow auditing of the entire educational process. Auditing is a fundamental tool for maintaining this teaching modality, ensuring the transparency of the process and obtaining good results in its implementation. In addition to clear rules, the regulation should define who are responsible for auditing management authority and their responsibilities.

In this sense, it should be noted that basically audits in virtual learning environments are divided into technical and pedagogical. The technical auditor is responsible for the entire information system and its infrastructure. This role can be performed by a specialist or by a group of information technology (IT) specialists. The pedagogical auditor, on the other hand, is responsible for controlling the evaluation process.

SMART *PAPER TECHNOLOGY* IN LARGE-SCALE ASSESSMENTS.

The evolution of digital technology in large-scale educational assessment can optimize the efficiency of assessment processes by simplifying the administration, collection, and analysis of data on a broad and diverse scale. However, even in the face of these remarkable advances, a significant portion of the student population remains excluded from access to technological tools that are fundamental to the learning process. Traditionally, the introduction of digital technologies in the classroom can be accompanied by accessibility challenges, especially in disadvantaged or developing communities.

In the context of large-scale assessment, the digital divide emerges as a challenge, since some students could not take the tests due to lack of access to electronic devices and digital resources. This can have direct implications on the participation of these students, compromising the process, effectiveness and validity of these assessments.

The lack of essential digital resources can intensify the disparities already present in the education system, resulting in difficulties for students to keep up with the school curriculum and fully engage in educational activities. This gap in accessibility to technology not only harms the individual development of students, but can also have broader implications, such as a lack of data or results in certain areas, which in turn can hinder the development and implementation of effective public policies in the field of education.

Given this scenario, it is imperative to seek innovative and inclusive solutions that can overcome the barriers of digital exclusion and ensure that all students have equitable access to education. It is in this context that *Smart Paper technology* emerges as a promising alternative, offering a comprehensive and accessible approach that seeks to reconcile traditional paper assessment methods with the advantages of the digital world.

> Smart Paper impacts nearly 5 million students in the state of Rajasthan, India, by enabling the equitable collection of educational data in 65,000 public schools. The government uses Smart Paper to measure students' competency levels and enables around 300,000 teachers to personalise learning in their classrooms.5 (PATEL, n.d.)

[5] Trecho Original: Smart Paper impacts nearly 5 million students in India's Rajasthan state by enabling equitable educational data collection in 65,000 public schools. The government uses Smart Paper to measure the competency levels of the students and enables nearly 300,000 teachers to personalize learning in their classrooms.

A *Smart Paper* is a technological innovation that combines the traditional paper format with digital resources to provide a more dynamic educational experience. This technology allows the use of conventional equipment and materials without the need to purchase specific paper, printers or *scanners* .

Smart Paper is capable of communicating with electronic devices, such as *smartphones*, *tablets* or computers, through technologies such as *Radio Frequency Identification* (RFID), *Near Field Communication* (NFC), QR codes or specific printing technology. This enables direct interaction between paper and digital devices. Integration is made possible through a range of advanced technologies, including Application Programming Interfaces (APIs), which promote communication between *Smart Paper* and digital systems.

> Competency-based assessments in the state of Rajasthan, developed by Smart Paper, provide actionable data on each child's learning competencies. Paper-based assessments reach all children in grades 3-8 without infrastructure and technology limitations.6 (BRAND STORIES, 2024)

This technology enables an efficient and accurate evaluation of discursive questions. Using features such as handwriting recognition and natural language processing, it allows students to answer discursive questions directly on paper. This streamlines the correction process and expands the possibilities of large-scale educational assessment, making it more comprehensive, accurate, and tailored to the needs of students and educators.

In addition, *Smart Paper* offers the digital storage and sharing of information, which is especially relevant in the context of large-scale evaluation, allowing the results to be easily compiled, analyzed, and shared among those responsible for the evaluation, contributing to a more efficient and accurate management of evaluation data.

FINAL CONSIDERATIONS

The introduction of these innovations brings to light the growing permeability of technology in teaching and learning, offering new perspectives and approaches to large-scale assessment.

The adoption of virtual learning environments in these assessments makes it possible to collect and analyze data through *Learning Analytics* tools, revealing trends and gaps in the learning process. In addition, the application of techniques such as data mining

[6] Techo original: The competency-based assessments in Rajasthan state powered by Smart Paper provide actionable data about every child’s learning competencies. Paper assessments reach every grade 3 to 8 child without limitations of infrastructure and technology.

and machine learning, offers the ability to track, measure, and analyze a wide range of aspects of human behavior and cognitive capabilities during assessments, allowing for a detailed analysis of how students interact with the assessment environment, including their behavior patterns, personality traits, attitudes, cognitive processes and diverse skills.

During an evaluation on these platforms, each click, response time to each question, navigation patterns on the platform, among other aspects of interactions are collected and analyzed. This data, when processed, reveals patterns and trends that can indicate, for example, which questions were more challenging, how different types of students approach problems in different ways, or even identify possible cases of academic dishonesty.

These *insights* enrich the understanding of students' performance and offer a more holistic and detailed view of their overall competencies, including problem-solving skills and the ability to cope with pressure. These analytics can help educators and developers of these environments to continuously improve teaching and assessment processes, customizing them to meet the specific needs of different student profiles and enhancing the interactivity and effectiveness of online learning platforms.

On the other hand, Item Response Theory (IRT) can be incorporated into these environments, transforming the creation and application of educational assessments. This integration facilitates the elaboration of tests that adjust the complexity of the questions in real time, adapting to the individual performance of the students. This proves particularly effective in Computerized Adaptive Testing (TAC), where the difficulty of the questions is automatically calibrated as the student's response progresses, optimizing the assessment experience.

It is important to highlight the importance of students having well-developed digital skills so that they can fully demonstrate their knowledge in large-scale assessments using virtual learning environments. Otherwise, they may face difficulties in using these platforms during the process, compromising the result of the evaluations. In this sense, it is essential that educational institutions incorporate education in digital skills into their curricula and pedagogical practices to overcome the challenges imposed by the digital age in educational assessments.

In addition, for large-scale evaluations in virtual environments to be successful and their integration into public educational policies to be effective, attention to challenges related to academic integrity and data security is necessary to preserve confidence in the evaluation process. The implementation of these technologies in regions without adequate technological infrastructure faces major challenges, since the lack of access to specific equipment and materials can make the use of these innovations unfeasible.

Recognizing the urgency of ensuring equity in education and the importance of providing accessible solutions to all students, regardless of their location or economic status, *Smart Paper* technology emerges as a way to democratize access to educational assessments in a way that does not rely on advanced technologies or complex infrastructure resources. Prioritizing simplicity and effectiveness, *Smart Paper* makes it easy to take assessments by employing basic features that are widely available, ensuring that every student, in any context, can be assessed fairly and accurately.

This solution, adaptable to the resources and tools already existing in schools and communities, facilitates the execution of large-scale evaluation processes and the realization of advanced educational activities. In this way, a range of possibilities is opened up for the significant expansion of data collection and analysis related to the learning process of students from remote or underdeveloped areas,

In this way, it is possible to obtain more accurate and representative educational measures of students' abilities, overcoming the geographical and infrastructure limitations that often compromise access and quality of education.

This democratization of access to rich and detailed educational data allows authorities to make evidence-based decisions about necessary interventions, resource allocation, and development of more effective strategies to improve educational outcomes.

In addition to being able to overcome geographical and infrastructure barriers, these technologies pave the way for the development of assessments for groups that have historically been forgotten or not properly assessed, such as those with some type of disability or learning disorder. This advance also facilitates the inclusion of a broader spectrum of learners, ensuring a fair and representative assessment of their skills and knowledge.

Another significant benefit of large-scale digital assessments lies in the ability to incorporate a variety of media, such as images, videos, and sounds, into their assessment formats. This multifunctionality enriches the assessment process, making it more engaging and interactive, finding direct resonance in the theory of learning styles, which recognizes the diversity in the ways individuals absorb and process information, as well as ensuring that students can demonstrate their knowledge and skills in the most appropriate way.

As technology is progressively integrated into the educational process, there is a transformation not only in the methods of content delivery, but also in the modalities of interaction between students and between them and the didactic material. As a result of this integration, there is a need to evolve evaluation methods, in order to incorporate, in addition to the measurement of conventional knowledge, the evaluation of digital skills, collaboration skills in online environments, and the ability to solve problems within virtual contexts. In this context, it becomes essential and imperative to train teachers, who need to be prepared to use these new tools and incorporate them into their pedagogical practices.

By reflecting on the current landscape and potential future trajectories of education, the integration of technologies in large-scale assessments marks an important step towards building a more equitable, effective, and adaptive education system. The transition to digital assessment practices is not only a response to the demands of an increasingly digitized world, but also an opportunity to rethink and revitalize educational processes, making them more relevant to the needs and challenges of the twenty-first century. This change paves the way for exploring new learning perspectives, enabling each student to fully develop their potential in an ever-changing world.

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