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From Assessment to Action: AI-Driven Competency Analytics in Foundational Learning

DSAI White Paper - July 2025

This whitepaper is created to summarize how Precision Learning can improve the access and leaning outcomes based educational access to low and deprived socially economic background in remote regions through Deepspatial GeoAI technology.



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Executive Summary

The present white paper proposed an Artificial Intelligence (AI) based innovative solution that bridges the gap between the assessment and action in foundational learning. Deepspatial AI approach leverages the advanced psychometric models like Item Response Theory (IRT) and the Graded Response Model (GRM) which shifts the paradigm from the summative evaluations to diagnostic, and skill-based analysis. The major challenge associated with the traditional assessment method in school education fall short of diagnosis what students truly know and can do and foundational learning particularly in Grades 3, 5, and 8 is a critical predictor of long-term educational success. Furthermore, the traditional approach focuses heavily on marks and ranking, offering limited insights into specific competencies or actionable guidance for teachers and policymakers. The current GeoAI approach utilized and automated the scoring process, tags each item into specific Learning Outcomes (LOs), and generates heatmaps and banding classifications that identify students' proficiency levels from Below Basic to Advanced. This allows for granular LO-wise diagnostics at both student and school levels, transforming raw scores into meaningful insights. Deepspatial AI platform provides class-wise analysis, LO-wise heatmaps, competency banding system, and skill trajectory modelling to visualize learner strengths and gaps, monitor student progression, guide remediation and enrichment, respectively. By converting assessment data into precise, real-time learning diagnostics, this technology empowers education systems to move toward evidence-based instruction and scalable personalization. Deepspatial's AI-driven solution supports the global mission of building competency-driven, equitable learning environments making personalized foundational education a practical reality for countries around the world.

1. Introduction

Artificial Intelligence (AI) attempts to simulate the natural intelligence of human into the machines. AI have potential to acquire from the past experiences and the AI application is rapidly growing in various fields like health, agriculture, industries, and education. In education sector, the machine learning algorithms can support the instructors in systematic monitoring of student's performance in the courses and can take preventive measures to support the struggling students and improves the students' final outcomes. From previous experience, it is also observed that AI can support the higher education to improve the quality of education by improving the students' final outcomes. The

assessment in education plays a key role in the learning process as it serves to evaluate the students understanding, guide instructional decisions, ensures the educational objectives which are being met. Further, the effective assessment system provides a meaningful feedback, foster learning improvement, and support the teaching practices with the desired learning outcomes. Thus, the Artificial Intelligence based tool is designed to identify the gaps between the assessment to action in foundational learning which further measures the student performance, enhances the student's engagement, motivation, and overall learning progress[1]. Traditional assessment method involves such as written examination, quizzes, and consistent tests, have long been used to evaluate the students' knowledge and skills. Learning process follows a summative assessment approach which is tested and measured at the end of the course or instructional period.

Further, the traditional approach has various limitations which can fail to arrest the diverse abilities and learning styles of students and may not account for individual student differences such as cultural background or unique learning needs, which further can result in inadequate feedback, impeding students from understanding their learning gaps[2,3]. Thus, these limitations focus on the need for the more dynamic personalized, and scalable assessment approach that can be better align with the needs of 21st-century education. Recently, the global shift from traditional content-based instruction to competency-based learning (CBL) in foundational education has necessitated new tools for real-time, and granular assessment. Competency can be considered as a combination of individual's Knowledge (K), Skill (S) and Attitude (A). The potential of AI-driven analytics to close the gaps between the assessment and actionable intervention, particularly in foundational literacy and numeracy (FLN)- a core area of concern. Thus, the present white paper explores competency-based AI models focusing on learner outcomes rather than the time spent in the classroom. Moreover, the Competency-Based Education (CBE) prioritizes the mastery, flexibility, and personalization, aligning with the United Nations' SDG 4.1.1a indicator the proportion of children achieving minimum proficiency in reading (e.g., Class 3, 5, 8) across English, Maths, Science[4,5].

2. The Deepspatial GeoAI Framework

Artificial Intelligence and Machine Learning-based Deepspatial AI model represents a cutting-edge solution approach to transform the traditional assessments into actionable learning diagnostics. GeoAI technology is grounded in psychometric theory, AI-driven analytics, and foundational learning principles which shifts the focus from test scores to competency mastery, facilitating both personalized learning and institutional

improvement. Deepspatial GeoAI powdered platform analyses the student response patterns, integrated with the psychometric models mainly Item Response Theory (IRT) and the Graded Response Model (GRM) to:

- Generate competency-level diagnostics.
- Automate and standardize scoring.
- Map students to learning trajectories.

GeoAI technology has advantages over the conventional assessment approach that produces skill-level insights aligned with the curriculum frameworks.

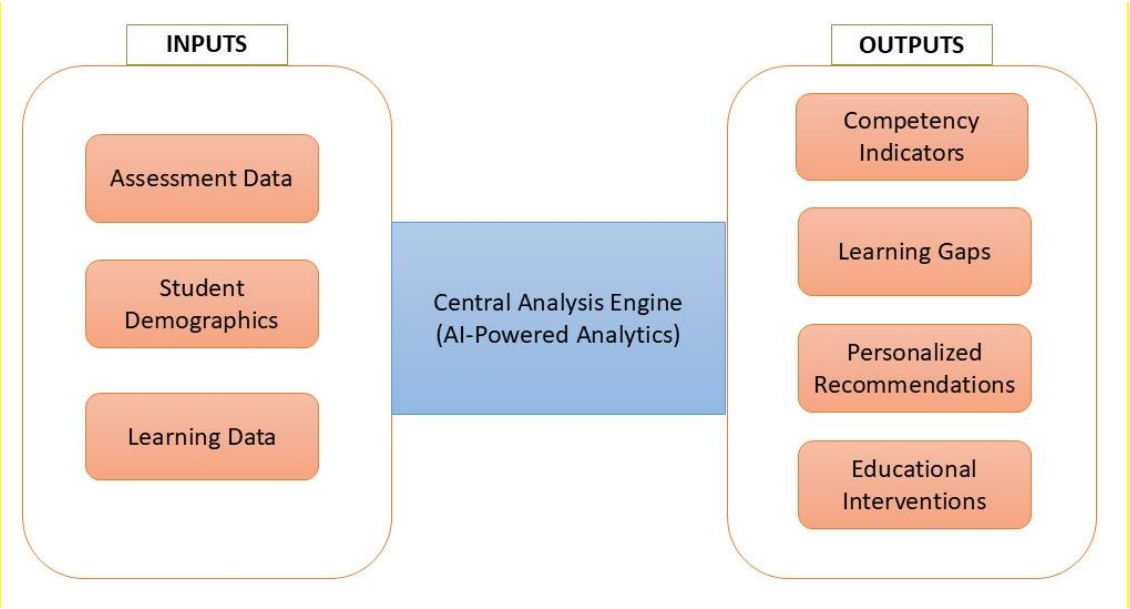


Figure 1. Overview of the AI-powered analytics engine.

2.1. Core Components of GeoAI Technology

a) Psychometric Engine (IRT, GRM Integration)

- The platform uses Item Response Theory (IRT) and the Graded Response Model (GRM) to measure latent competencies rather than raw scores. Each item is calibrated for difficulty and discrimination, allowing personalized interpretation of student ability.

b) Automated Scoring System

- Using NLP and AI algorithms, the platform automates scoring of both objective and selected subjective response formats. This reduces evaluator bias and increases feedback speed.

c) Banding & Competency Classification

- Students are grouped into performance bands: Below Basic, Basic, Proficient, Advanced. This allows for targeted interventions and monitoring over time.

d) Learning Trajectory Modeling

- AI/ML platform uses previous performance data to model student skill growth, predict future mastery, and recommend content/interventions - a key element of precision learning.

2.2. Outcome-Driven Reporting Features

- **LO-wise Heatmaps**
  - Every student's academic performance is tagged to specific Learning Outcomes (LOs).
  - Heatmaps generated and visualize mastery across the classes and subjects (e.g., English, Math, Science).

- **School and Class Dashboards**
  - Accumulated insights at the class or school level.
  - Enables administrators to identify systemic learning gaps, plan training, and reallocate resources.
- **Feedback for Remediation**
  - Real-time feedback loops help teachers adjust lesson planning, group instruction, and individual support.

2.3. Dashboard Unique Features

Deepspatial AI dashboard has unique features over the traditional dashboards or simple assessments such as:

- Diagnostic, not just descriptive.
- Aligned with curriculum-linked competencies.
- Scalable across classrooms and geographies.
- Empowering for teachers, not replacing them.

Table 1. Comparative Literature.

Feature	DSAI Platform	Traditional Systems	Literature
Psychometric Modeling	✔	✘	Embretson & Reise (2000) – Item response theory for psychologists
Competency Tagging	✔	✘	Wilson (2004) – Construct Mapping
Automated Feedback	✔	✘	Heffernan & Heffernan (2014) – ASSISTments Ecosystem
School-Level Decision Support	✔	Partial	Wayman et al. (2005) – Data-Driven Decision Making

Deepspatial's AI framework creates psychometrics, AI, and curriculum-aligned competency mapping to transform and address the foundational learning. It represents a scalable model that supports students, teachers, and administrators in achieving the personalized, equitable, and data-informed learning outcomes.

3. From Data to Diagnosis

Geospatial AI technology transforms the student-level assessment data into the granular, actionable, and personalized diagnostics using a robust combination of psychometrics, machine learning, and curriculum mapping. The present section shows the dashboard operations from the raw data ingestion to produce a competency heatmaps, multi-level analytics (class-wise insights, and subject-specific applications) and growth projections which further supports the decision making at each stakeholder including the student, teacher, school, and system.

3.1 Data Sources and Psychometric Modeling

The various set of diverse data required and utilized:

- Formative and summative assessments.
- Paper-based and digital response sheets.
- Subject-wise tests in English, Mathematics, and Science (Grades 3, 5, 8).

These datasets are required to clean and check for inconsistencies, duplicate entries, and missing values, ensuring standardized input for AI modeling. The responses are item-tagged to specific Learning Outcomes (LOs) from national frameworks like NCERT Learning Outcomes. Once cleaned, response datasets are processed through the Item Response Theory (IRT) and Graded Response Models (GRM), which further estimates the:

- Item difficulty
- Student latent ability (theta score)
- Discrimination parameters (how well an item differentiates between low and high performers)

These models go beyond raw marks, offering scale-free, fair, and personalized measures of ability.

3.2 Competency Mapping and LO-wise Heatmaps

- **Learning Outcome (LO) tagging**

  Each assessment item in the system is pre-tagged to a specific LO and these LOs are aligned with the Learning Outcomes and region-specific competency frameworks. Thus, through the LO tagging, every student response is linked to a defined skill area and aggregated results become meaningful at the skill level, not just at the test score level.

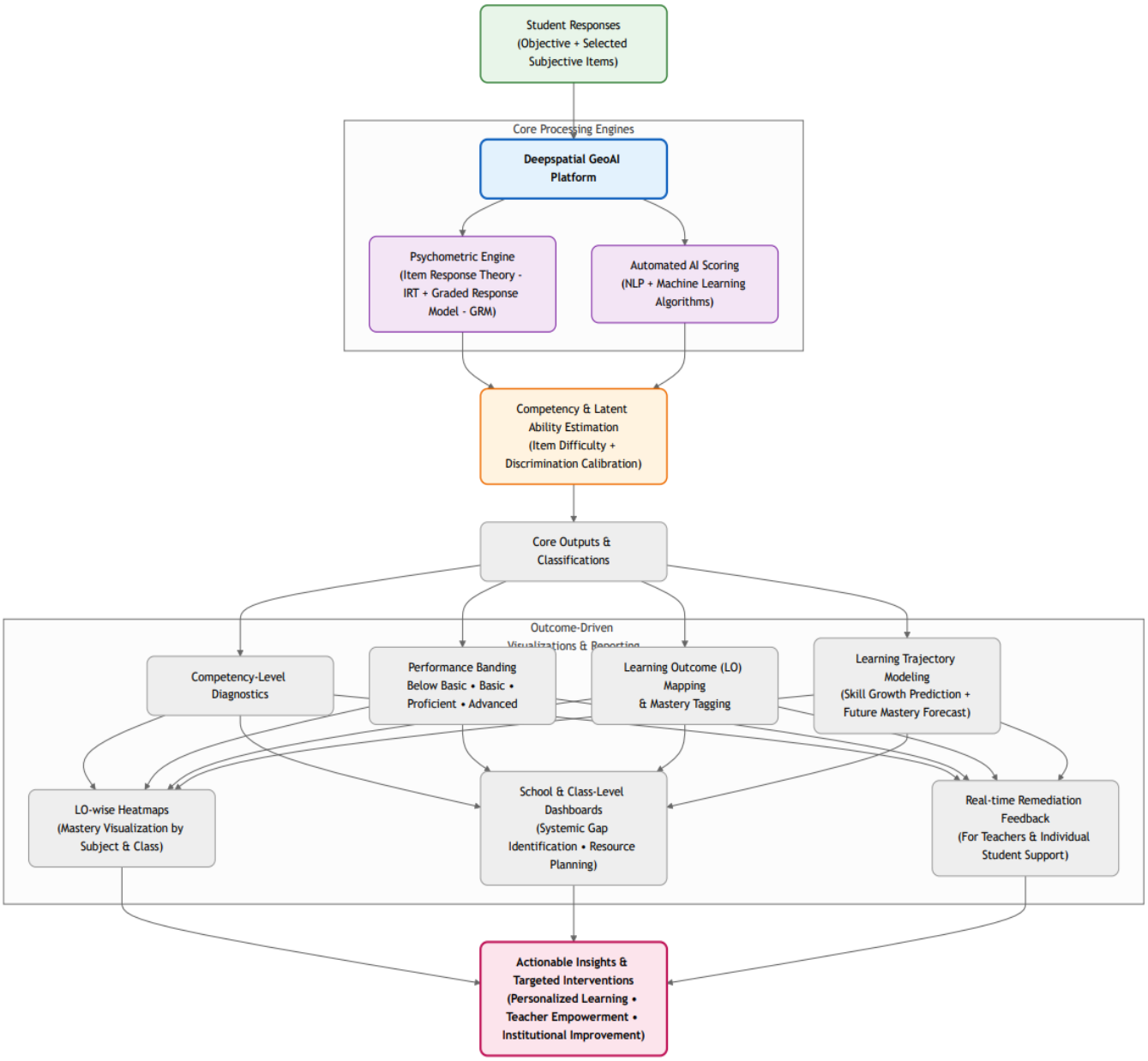


Figure 2. Geo-AI modeling flow from datasets collection, ingestion, modeling, and decision-support system.

- **Diagnostic visualizations at student and school level**

  Once LO-tagged responses are collected, the platform can generate interactive heatmaps that visualize performance data across students, learning outcomes, and schools.

  Key Features:

  - Student View: Shows which specific LOs are mastered, emerging, or need intervention.
  - Classroom View: Teachers see which LOs are strong/weak across the class.
  - School-Level Dashboards: Aggregated LO proficiency data help leadership to

identify the trends and intervention zones.

The color-coded heatmaps typically follow a traffic-light pattern

- 🟢 Green = LO mastered
- 🟡 Yellow = Emerging/LO partially met
- 🔴 Red = LO not met/Needs urgent intervention

The information obtained are quite useful to the educators to shift from "Who failed the test?" to "Which concepts are not understood, and by whom?"

3.3 Banding System and Personalized Insights

- **Skill-level banding**

Students are classified into performance bands such as:

- Below Basic
- Basic
- Proficient
- Advanced

These bands are derived based upon the AI-clustering and psychometric thresholds.

The banding system support us:

- Teachers differentiate instruction.
- Schools identify learning gaps by subject/grade.
- Administrators allocate resources and plan interventions.

- **Growth path modeling and student learning trajectory**

By integrating prior assessments, the platform can generate longitudinal profiles of each student's progress. Using predictive analytics (e.g., logistic regression, gradient boosting), the system:

- Projects future proficiency.
- Recommends targeted content.
- Flags students at the risk of regression.

4. Teacher Empowerment through Feedback Loops

One of the most impactful dimensions of our platform lies in its ability to transform the teacher training and classroom practice through continuous, and data-informed feedback system. Hence, rather than positioning teachers as a passive recipients of student performance reports, the platform empowers them as data-driven facilitators of personalized and competency-based learning. Traditional in-service teacher training in many regions is generic, infrequent, and disconnected from real classroom needs. AI

technology addresses by generating real-time, classroom-specific feedback on student learning outcomes which further enables the responsive professional development.

Key Features:

- LO-wise diagnostics highlight patterns of misconceptions linked to instructional gaps.
- Class-wise heatmaps support to identify which topics require re-teaching or differentiated instruction.
- Training modules can be dynamically adapted based on recurring challenges in learner performance.

4.1 Use of Diagnostics to Tailor Pedagogy

Furthermore, the GeoAI platform helps pedagogical adaptation by linking each assessment item to specific LOs and providing performance analytics at the LO level. This enables teachers to:

- Re-group students by mastery levels (e.g., for peer learning or remediation).
- Modify lesson pacing and methods for struggling learners.
- Integrate formative check-ins that align with skill-specific gaps.

Teachers no longer required to rely on the intuition alone the instructional decisions which are guided by the data that reflects each learner's needs.

4.2 Evidence-Based Instructional Design

Using heatmaps, banding profiles, and skill trajectory data will support the design instruction like:

- **Competency-based**: Built around targeted learning goals.
- **Differentiated**: Adjusted for groups with various mastery levels.
- **Iterative**: Informed by continuous assessment cycles.

School administrators can identify systemic teaching gaps and respond by tailoring teacher capacity-building efforts leading to instruction that evolves with the learner.

5. School-Level Decision Intelligence

School-level diagnostic and intelligence input is critical for the school leaders, and administrators from the aggregated, and actional insights for personalized and realistic instruction. GeoAI technology helps the institutional analytics tools that can inform the decision-making process at the school, cluster, and district level. Thus, by providing the LO-wise heatmaps, performance banding, and intervention flagging at the scale, the platform suggests the school level decision Intelligence the ability to use real-time data to drive an equitable, and evidence-based planning.

5.1 School Heatmaps and Leadership Dashboards

GeoAI platform aggregates student diagnostic data into school-level heatmaps that visualize performance across subjects and grades. The dashboard present:

- Class-wise or subject-wise performance clusters.
- LO wise distribution across classrooms.
- Band-wise student groupings (Below Basic to Advanced).
- Skill-based gaps (e.g. reading fluency, number sense).

These dashboards are intended for principals, cluster coordinators, and district officials to track the performance trends and benchmark progress over the time.

5.2 Identification of Intervention Zones

The platform uses AI-based pattern detection to flag intervention zones such as:

- Schools with systemic underperformance in specific LOs.
- Classrooms with high concentrations of Below Basic learners.
- Geographies where foundational skills lag regional averages.

This granular intelligence enables targeted interventions:

- Deploying additional teaching resources.
- Planning remedial camps or bridge courses.
- Triggering school-level audits or deeper pedagogical support.

5.3 Support for Resource Allocation and Improvement Planning

The datasets from the platform can also inform strategic planning by:

- Highlighting where to direct teacher training funds.
- Prioritizing infrastructure upgrades (e.g., digital labs, libraries) in learning-deficient schools.
- Informing CSR/PPP decisions for targeted school support.

Moreover, the geospatial integration adds a location-based intelligence layer, showing how demographics, accessibility, and infrastructure impact learning outcomes particularly in remote or underserved regions.

6. Impact Highlights

The GeoAI framework integrating AI, psychometric modelling, and geospatial intelligence is intended not just a diagnostic tool but as a catalyst for the systemic educational transformation. The impact highlights are provided to demonstrate its real-world value in the foundational educational reform, particularly in the underserved and remote regions:

6.1 Improved Student Engagement through Personalized Learning

- Psychometric-driven analysis (e.g., IRT, GRM) enables tailored feedback per student, helping educators to adapt instructional strategies to individual learning levels.
- Visual and instant feedback systems provide students ownership of learning, strengthening self-efficiency and classroom participation.

6.2 Data-Backed Teacher Capacity Building

- The system integrates competency heatmaps and learning gaps diagnostics that feed into customized teacher training paths.
- The system supports evidence-based pedagogical planning, allowing educationalists to more focused on concepts that the students usually struggle.
- Teachers receive timely feedback loops, enabling continuous professional development aligned with the classroom realities.

6.3 Alignment with National and Regional Education Initiatives

- The advanced Geospatial and AI-driven capabilities support alignment with global and national foundational literacy and numeracy (FLN) goals, competency-based curricula, and learning outcome monitoring frameworks widely adopted by ministries of education and international development agencies.
- Through real-time dashboards and geo-tagged performance analytics, education administrators can:
    - Monitor foundational learning progress at school, regional, or national levels.
    - Allocate resources and interventions more effectively.
    - Strengthen data-driven decision-making, governance, and accountability across the education ecosystem.

7. Strategic Implications

The implementation of Deepspatial's AI-driven competency analytics represents a strategic advance in how foundational learning is assessed, interpreted, and acted upon at scale. The system's design supports seamless integration with national education data infrastructures, diverse policy environments, and global education improvement agendas.

7.1 Alignment with Global Education Priorities

The framework directly supports internationally recognized goals for improving learning quality and equity:

- **Competency-Based Education Reform:** The platform enables a shift from traditional content-based testing to competency-based, outcome-aligned assessments that help countries modernize their foundational learning systems.
- **Personalized and Data-Driven Learning:** AI-powered diagnostics facilitate individualized learning pathways, enabling governments and education systems to implement large-scale personalization, particularly in early grades.
- **Sustainable Development Goal (SDG) 4.1:** SDG ensure inclusive and equitable quality education which promotes the lifelong learning opportunities for all, specifically through the data-driven improvements in early-grade learning outcomes.
- **Teacher Capacity Development-SDG 4.c:** Provides diagnostic insights that inform teacher training programs, improve instructional practices, and strengthen continuous professional development systems worldwide.

7.2 Scalable and Replicable Model for Public Education Systems

- Designed for multilingual, multicultural, and socio-economically varied environments, with scalability from school to regional to national levels.
- The AI-driven analysis, combined with offline-compatible data collection models which makes it suitable for rural and remotely region schools that supports the equitable access.
- Advantage of modular deployment ensures cost-efficiency which allows the states to adopt phase-wise according to their preparedness and policy focused.

7.3 Integration with National Digital Infrastructure

The system is aligned with global key education data systems, supporting end-to-end digital governance. Examples include:

- **National Digital Learning Platforms**: For sharing curriculum resources, assessments, and teacher training content.
- **Education Management Information Systems (EMIS):** For harmonizing school, student, and teacher data with real-time learning diagnostics.

- **National Assessment and Performance Monitoring Systems:** Supports alignment with country-level learning assessments, quality indices, and monitoring frameworks for transparent reporting and policy planning

8. Conclusions

Foundational learning forms the bedrock of quality education and is universally recognized as a fundamental right of every child. In-spite of decades of educational reform, a persistent gap between the assessment and action in early-grade child education learning was observed. Traditional assessment methods, which often emphasize the summative scores and student rankings, fall short in diagnosing specific learning gaps or informing targeted pedagogical interventions. Thus, this white paper underlines the urgent need to transition from traditional, summative assessments to a more dynamic, diagnostic, and competency-based approach in foundational learning. Deepspatial's AI-powered platform, grounded in psychometric principles and advanced GeoAI analytics, offers a transformative solution that assesses the students' knowledge and learning. By integrating the advanced Deepspatial AI models, the system can generate the learning outcome (LO)-wise insights, automates scoring, and visualizes student trajectories through intuitive dashboards and heatmaps. This allows for real-time, actionable feedback to guide instruction, resource allocation, and student remediation thereby reducing the gap between assessment and meaningful educational action. Thus, Deepspatial GeoAI solution empowers educators, school leaders, and policymakers to move beyond one-size-fits-all evaluations and towards personalized, competency-driven education that aligns with national priorities like FLN (Foundational Literacy and Numeracy) and global goals such as SDG 4.1.1a. As low- and middle-income countries strive to ensure minimum proficiency for all learners, AI-based tools like this and represent not just technological innovation, but a critical step toward equity, inclusion, and quality in education at scale.

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