

NO-CODE ARCHITECTURES AND LEARNING ENVIRONMENTS IN EARLY CHILDHOOD AND PRIMARY EDUCATION (I): FUNCTIONAL TAXONOMY AND STRUCTURAL MODELS

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Abstract

This study investigates integrating no-code architectures, specifically cloud-based platforms such as Google AppSheet®, within Early Childhood and Primary Education (ECPE). To meet the urgent need for flexible digital transformation in educational environments, the research establishes a multidimensional functional taxonomy to transform mobile relational databases into robust psychopedagogical tools. By analyzing the structural dichotomy between administrative backend control panels and interactive child-facing frontends, the study bridges the gap between software development and educational design. The proposed methodological framework evaluates technical affordances against developmental, cognitive, and organizational constraints. The findings provide educators, instructional designers, and researchers with a systematic approach to repurposing productivity-oriented cloud platforms into secure, scalable, and pedagogically aligned digital ecosystems for modern classrooms.

Keywords: No-code architectures; Google AppSheet; functional taxonomy; early childhood and primary education (ECPE); pedagogical engineering;

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1. Introduction

The contemporary educational landscape is undergoing a profound digital transformation, driven by the need to adapt teaching and administrative practices to the realities of the information age. Within Early Childhood and Primary Education (ECPE), this transition brings both opportunities and significant challenges (Goswami & Chauhan, 2025). While educational technology (EdTech) offers vast potential for personalizing learning and optimizing classroom management (Halim, 2023; Losdo & Cerna, 2026), educators frequently face a double bind: commercial software solutions are either too rigid to fit specific curricular needs or too complex to be customized without advanced programming skills. In recent years, the emergence of no-code platforms - such as Google AppSheet® - has fundamentally altered this paradigm.

By allowing non-technical users to build secure, cloud-connected mobile applications through visual interfaces and relational databases, no-code technology bridges the gap between technical capability and pedagogical practice (as presented in Fig. 1). However, despite the exponential growth of practical implementations, academic literature lacks a structured, conceptual framework to classify and evaluate these tools within early and primary education.



Figure 1. Digital transformation in ECPE - bridging administrative challenges and pedagogical practices via Google AppSheet® platform
(source: image generated with Google Gemini, v. 3.1 Pro)

This study addresses this theoretical and practical gap by proposing the first comprehensive functional taxonomy of Google AppSheet® solutions in a pedagogical context. By analyzing applications through a multidimensional framework - encompassing pedagogical purpose, data architecture complexity, and human-computer interaction (Parveen et. al, 2026) - this research

establishes a conceptual foundation for designing, evaluating, and implementing mobile solutions in ECPE. Furthermore, the study explores the profound implications of these architectures on teacher agency, the reduction of administrative burnout, and the alignment with constructivist learning principles.

2. Literature review and research gap

2.1. The evolution of digital technologies in ECPE

In recent decades, the integration of digital technologies into educational environments has evolved significantly. While initial approaches focused predominantly on computer labs and desktop software, contemporary paradigms highlight mobile learning (m-learning) and the ubiquity of smart devices. In ECPE, this integration must be approached with pedagogical caution, ensuring that technology serves as a cognitive scaffold rather than a distractor - a significant transformation characterized by a pedagogical approach that is child-centered, inclusive, and technology-supported (Rahman & Moh, 2025). Constructivist theories and the principles of Universal Design for Learning (UDL) suggest that digital tools are most effective when they support active learning (Adamah & Gariba, 2026), collaboration, and the personalization of educational experiences according to each child's developmental rhythm.

2.2. The emergence of no-code platforms in educational settings

Against the backdrop of the need for digital flexibility, no-code platforms have emerged as a revolutionary solution for educators and academic institutions. Unlike traditional software development - which requires advanced programming skills - no-code platforms (such as Google AppSheet®) empower non-technical users to build functional mobile and web applications through visual interfaces, automated workflows, and centralized cloud databases (Giraldo & Laso, 2025). In educational contexts, this technological democratization allows teachers to design custom digital solutions tailored directly to their classroom needs, by passing the rigid limitations of commercial off-the-shelf software and significantly reducing institutional dependency on external IT specialists.

2.3. Literature gaps and the need for a dedicated taxonomy

Despite clear practical advantages, current academic literature dedicated to no-code technologies in education presents a major limitation: most existing studies are predominantly descriptive, oriented toward isolated cases of digitization for attendance or general administrative tasks, lacking a unified conceptual framework.

Specifically, there is a critical gap between:

- The native technical capabilities of no-code platforms (database architecture, relational structures, automation logic).

- The strict psycho-pedagogical requirements of early childhood and primary education (the need for adapted ergonomic design, protection of minors' data, support for formative assessment, and the reduction of the educator's bureaucratic burnout syndrome).

The absence of a functional taxonomic framework causes teachers and researchers to operate without a common language. Without a rigorous classification showing what type of no-code solution serves what pedagogical purpose and with what structural complexity, digital innovation risks remaining a fragmented endeavor. This study aims to bridge this literature gap by establishing the first functional taxonomy for Google AppSheet® solutions in a pedagogical context.

3. Methodology and conceptual design

To develop a rigorous and applicable taxonomic framework in educational sciences, the methodological approach adopts a structural, functional, and comparative analysis perspective. This method is not limited to a simple inventory of buttons or technical functions within a no-code platform (Google AppSheet®) but rather correlates the native capabilities of data architecture with the specific requirements of pedagogical design in ECPE. The construction of the taxonomy starts from the premise that a mobile educational application is not an isolated element, but rather a functional node within a hybrid learning ecosystem. Consequently, the methodology utilizes a multidimensional classification model, evaluating solutions through the lens of three fundamental axes: pedagogical purpose, data architecture complexity, and human interaction dimension.

3.1. Methodological approach and conceptual design

To systematically investigate the integration of no-code architectures - specifically leveraging cloud-based platforms such as Google AppSheet® - within ECPE, this study adopts a rigorous mixed methodological approach combining structural taxonomy development, comparative architectural analysis, and pedagogical alignment. The research moves beyond traditional software development paradigms by evaluating how flexible, cloud-native database environments can be repurposed to serve as robust pedagogical infrastructures.

The core methodological premise rests on the dual operational nature inherent in educational no-code deployments. Specifically, the framework analyzes the structural dichotomy between:

- The interactive frontend environment, configured for direct, safe, and engaging utilization by young learners under pedagogical guidance.
- To operationalize this dual analysis, the research framework establishes a multidimensional taxonomy built upon three foundational analytical pillars: structural relational data modeling, workflow automation capabilities, and platform-native interface constraints. This tripartite model enables a systematic mapping between the technical affordances of Google AppSheet® and the specific developmental, cognitive, and organizational demands of educational settings.

3.2. Multidimensional classification criteria

The functional taxonomy proposed is structured based on the following three major criteria:

- **Pedagogical purpose dimension** classifies applications according to their direct utility in educational practice, dividing them into three essential subcategories:
 - **Solutions oriented towards classroom management and administrative efficiency** (tools designed to reduce the teacher's bureaucracy);
 - **Solutions oriented toward formative assessment and behavioral observation** (tools for tracking children's achievements);
 - **Solutions oriented towards interactive environments and learning resources** (tools centered on the student's learning experience).
- Data architecture complexity dimension evaluates the technical complexity of how the Google AppSheet® platform organizes information:
 - **Level 1 (single flat tables)** - simple tabular structures suitable for quick attendance lists or resource inventories.
 - **Level 2 (binary relational databases)** - parent-child type relations (e.g., *the direct link between a student's file and their activity portfolio*).
 - **Level 3 (complex relational architectures)** - multi-table systems interconnecting the preschooler's profile, curricular objectives, formative assessments, and reports generated for parents.
- **Human-Computer Interaction (HCI) dimension** analyzes who the primary user of the mobile interface is during classroom interaction:
 - **Exclusive use by the educator** (backend-type interfaces or discreet teacher control tools).
 - **Guided or assisted interactive use** (friendly interfaces with intuitive elements used by preschoolers or young students under the educator's guidance).

3.3. Taxonomy validation cycle

To guarantee construct validity, the proposed taxonomic framework follows an iterative cycle of literature analysis in pedagogical design and an evaluation of technical feasibility by simulating real usage scenarios in kindergartens and primary schools. This methodology ensures that the taxonomy does not remain a mere theoretical abstraction, but becomes a robust operational framework, prepared to underpin the detailed categories presented in the subsequent section of the current dedicated study.

4. Functional taxonomy of Google AppSheet® solutions in a pedagogical context

Based on the multidimensional methodological criteria established previously, this study proposes a functional taxonomy structured around 3 major categories of solutions developed on the Google AppSheet® platform. This classification provides a clear conceptual map for digital design in ECPE, correlating the native capabilities of the no-code platform with specific didactic requirements.

4.1. Category A. Classroom management and administrative optimization solutions

The first category of taxonomy targets solutions designed to reduce the "invisible burden" (bureaucracy and resource management) that consumes a significant portion of educators' time, leaving less space for direct interaction with children.

- Data architecture: Primarily relies on level 1 and level 2 structures (flat tabular sheets and simple list-event binary relations).
- Indirect pedagogical function: Although they do not directly interact with preschoolers or young students, these applications create an orderly, safe, and predictable educational environment.
- Functional examples in Google AppSheet®:
 - **Digital attendance and safety registers** - mobile drop-off and pick-up systems that automatically log the time and authorized people, ensuring institutional security.
 - **Dynamic learning center inventories** - applications through which the educator monitors the availability of teaching materials, role-play games, or educational toys in the classroom.
 - **Scheduling and communication systems for family partnerships** - mobile solutions dedicated to the flexible organization of parent-teacher conferences or pedagogical consultation hours, optimizing the external administrative workflow of the class.

4.2. Category B. Formative assessment and progress monitoring solutions

The second category groups tools dedicated to measuring and recording individual student progress. In early childhood and primary education, assessment is not based on rigid standardized testing, but on systematic observation, progress logs, and behavioral grids.

- Data architecture: Utilizes level 2 and level 3 structures (relational databases linking the individual child's profile to specific curricular indicators).
- Direct pedagogical function: Supports the teacher in conducting rapid, non-intrusive formative assessment based on longitudinal evidence.

- Functional examples in Google AppSheet®:
 - **Behavioral and cognitive observation journals** - mobile tools through which the educator quickly checks off the preschooler's achievements across developmental domains, optionally attaching voice notes or images as evidence of progress.
 - **Individual digital portfolios** - solutions that centralize the young student's evolution throughout the entire school year, facilitating transparent and secure communication with parents.
 - **Multi-criteria curricular progress matrices** - complex relational databases tracking the achievement of specific objectives from the school curriculum (across experiential domains or subjects), automatically generating individualized evolution reports for each student.

4.3. Category C. Interactive environment and learning resource solutions

The third category represents the most advanced level from an architectural standpoint and the closest to direct student interaction. In this case, the Google AppSheet® platform is used to create digital resource centers or guided learning interfaces aligned with the principles of UDL.

- Data architecture: Involves level 3 complex relational architectures, integrating media databases (images, audio files, accessible texts) and conditional navigation logic.
- Direct pedagogical function: Stimulates active student engagement, supporting learning through discovery, guided practice, and cognitive accessibility.
- Functional examples in Google AppSheet®:
 - **Digital literacy and numeracy centers** - user-friendly applications featuring large buttons and intuitive visual elements, used on classroom tablets under the educator's guidance for matching, recognition, and logic games.
 - **Interactive environmental exploration guides** - mobile resources used in extracurricular or outdoor activities, where children (assisted by the teacher) discover natural elements and record structured observations within the application.
 - **Multimedia digital centers for arts and creative expression** - interactive solutions providing visual and auditory support for musical activities, visual arts education, or guided role-playing games, facilitating the personalization of the learning experience according to each student's pace.

5. Discussions and conclusions. Pedagogical and architectural implications

The functional taxonomy of Google AppSheet® solutions proposed in this study goes beyond a mere technical classification (see Fig. 2), generating profound implications for pedagogical design, daily educational practice, and the professional development of educators in ECPE.

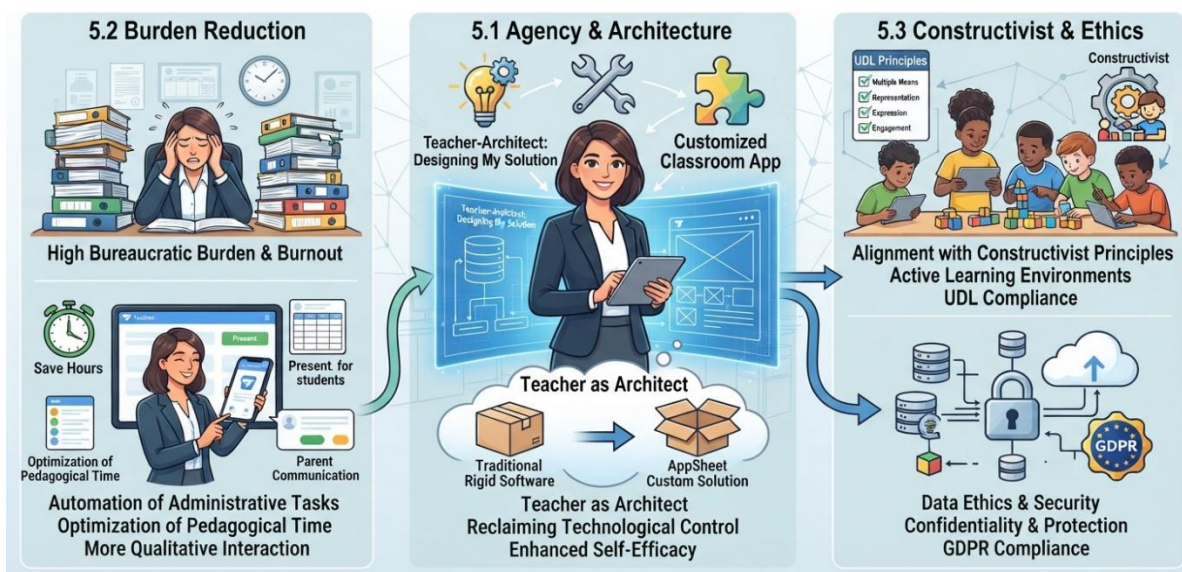


Figure 2. Pedagogical and architectural implications of Google AppSheet® solutions in ECPE
(source: image generated with Google Gemini, v. 3.1 Pro)

5.1. The reconfiguration of the teachers role

One of the most significant effects of adopting no-code architectures in the classroom is the reclamation of technological control by the teacher. Traditionally, educators have been captive users of rigid commercial educational platforms designed by engineers without a deep understanding of classroom realities. By utilizing tools such as Google AppSheet®, the educator becomes an architect of their own digital solutions. The teacher can model the database and interface precisely according to the specific traits of their group or class, adapting the pace of evaluation or observation tools to precise curricular objectives. This autonomy enhances the educator's sense of personal efficacy and considerably reduces resistance to digital change.

5.2. Reduction of bureaucratic burden and optimization of pedagogical time

Time dedicated to administrative and bureaucratic tasks represents one of the main sources of professional burnout among educators in preschool and primary education. Categories A and B of the proposed taxonomy demonstrate that intelligent automation of attendance, reports to parents, or formative observation sheets can save precious hours weekly. By transferring these tasks to a

mobile architecture based on centralized data, cognitive and physical time is freed up, which the teacher can reinvest in qualitative and affective interaction with preschoolers and young students.

5.3. *Alignment with constructivist principles and data ethics*

From a constructivist perspective, category C of the taxonomy validates the use of technology as an active learning environment rather than a means for the passive transmission of information. Interactive applications designed in a no-code regime can comply with the principles of UDL, offering multiple alternatives of representation and expression for children with different learning paces. At the same time, the flexibility offered by cloud platforms imposes a major ethical responsibility: data architecture developed in the preschool and primary environment must strictly comply with regulations regarding the confidentiality and protection of minors' data (GDPR). The proposed taxonomic framework serves precisely as an awareness tool, helping educational designers implement the correct level of data security starting from the application design phase.

6. Conclusions and future directions

This study has addressed a pressing need in contemporary educational technology literature: the necessity to move beyond the empirical and fragmented adoption of digital tools by providing a rigorous conceptual and structural framework for utilizing no-code platforms. By establishing a functional taxonomy of Google AppSheet® solutions within a pedagogical context, this research has demonstrated how the technical capabilities of mobile databases can be transformed into psycho-pedagogical instruments tailored to the specific needs of ECPE.

The major contribution of this endeavor lies in the creation of a zero milestone - a multidimensional structure that classifies applications according to pedagogical purpose (e.g., *administrative management, formative assessment, interactive environments*), data relational complexity, and the degree of human interaction. Through this classification, the study validates the shift of the educator from the passive role of software consumer to the active role of architect of their digital learning environment, while simultaneously supporting the reduction of bureaucratic burden and the optimization of constructivist practices in the classroom.

While the limitations of this study are theoretical and taxonomic in nature, they open ample opportunities for future research. The conceptual framework developed herein serves as an indispensable foundation for the entire series of planned investigations. Thus, article 2 in the series will build upon these taxonomic categories to analyze in depth the ergonomics of mobile interfaces, UX/UI design dedicated to children and educators, and the concrete impact of these architectures on cognitive accessibility in hybrid learning environments.

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