



# Co-designing with Children: Intuitive Insights for Growing Minds

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## Abstract

*This paper examines Growing Minds as a practice-based case study exploring how co-design with children can inform the development of sustainable educational tools and support participatory forms of environmental learning. Positioned at the intersection of design research, primary education, student engagement, and games in education, the project investigates how children's intuitive actions, play behaviours, and collaborative responses can shape both the design process and the learning experience.*

*The study responds to the limitations of instructional approaches to environmental education, where knowledge is often transmitted as abstract information rather than experienced through participation, exploration, and agency. Drawing on constructivist learning theories, participatory design, and the Reggio Emilia approach, children are framed not only as users but as active contributors whose insights emerge through embodied interaction, experimentation, hesitation, and improvisation.*

*Methodologically, Growing Minds employed an iterative, play-based co-design process with children aged 5 to 9 through repeated prototyping and playtesting sessions in classroom and garden-based learning environments. Observation, field notes, photographs, and reflective documentation were used to analyse how children interacted with materials, symbols, rules, group settings, and ecological concepts. Each design cycle informed the next, allowing the tool to evolve in response to children's behaviours rather than predetermined assumptions.*

*Preliminary findings suggest that children's participation improved the clarity, accessibility, and pedagogical relevance of the tool. Symbolic ecological icons supported stronger conceptual connections, while smaller group settings encouraged collaboration, autonomy, and peer learning. Outdoor sessions further strengthened sensory engagement and children's understanding of environmental systems as interconnected relationships rather than isolated facts.*

*The paper argues that play-based co-design can function both as a design methodology and as a pedagogical framework for transformative environmental education, supporting children's agency, collaboration, and long-term ecological understanding.*

**Keywords:** *co-design; children; play-based learning; environmental education; design thinking; iterative design; primary education*

## 1. Introduction

This paper examines *Growing Minds* as a practice-based case study exploring how co-designing with children can reveal broader pedagogical issues within environmental education. Although the project resulted in the development of a sustainable educational game, its significance lies not only in the final product but also in the design process itself. Children's intuitive actions, hesitations, play behaviours, and collaborative responses exposed gaps between adult assumptions and children's actual learning needs.

Positioned within the themes of games and media in education, student engagement, and primary and early childhood education, the study responds to the limitations of instructional approaches to environmental learning. Environmental knowledge is often presented as abstract information, while sustainable education requires more participatory, experiential, and action-oriented forms of learning [15], [16]. In this context, *Growing Minds* asks how educational tools can become more meaningful when they are shaped through children's lived experiences and everyday ways of understanding the world. Drawing on constructivist learning, participatory design, game-based learning, and the Reggio Emilia approach, the paper frames children not only as users of educational materials but as active contributors to educational knowledge [1], [3], [4], [7], [8], [12]. Methodologically, the project employed an iterative, play-based co-design process with children aged 5 to 9 through prototyping and playtesting sessions in classroom and garden-based learning environments.

The paper argues that play-based co-design can function not only as a design methodology but also as a critical lens for rethinking education. By observing children's intuitive insights, *Growing Minds*



demonstrates how educational tools can support more participatory, collaborative, and environmentally meaningful learning experiences.

## 2. Theoretical Background

This study draws on theories of play, experiential learning, participatory design, and game-based education to position *Growing Minds* as both a design process and a pedagogical case study. Play is understood not as an activity separate from learning, but as a primary way through which children explore ideas, test relationships, and construct meaning through action and interaction [2], [3]. Dewey's theory of experiential learning is also central to this study, as it emphasizes that meaningful education emerges through direct experience, reflection, and connection with real-life situations [1]. In this sense, environmental education becomes more powerful when children do not only receive information about sustainability, but actively experience ecological relationships through materials, movement, collaboration, and problem-solving. Through this approach, *Growing Minds* seeks to help children, as future actors of society, develop environmental awareness, climate consciousness, and a sense of responsibility toward the systems they are part of.

The study is also informed by the Reggio Emilia approach, which frames children as capable, expressive, and active meaning-makers rather than passive recipients of adult knowledge [4]. This perspective supports the methodological decision to treat children's intuitive actions, hesitations, negotiations, and playful responses as valuable research data. Participatory design further strengthens this position by arguing that users and communities should take part in shaping the tools and systems that affect them [7], [8]. In the context of *Growing Minds*, co-designing with children therefore becomes more than a method for improving an educational tool; it becomes a way of revealing the gap between adult assumptions and children's actual learning needs.

Game-based learning provides the final theoretical layer of the study. Educational games can support engagement by combining rules, symbols, goals, feedback, challenge, and social interaction [12], [13]. For environmental education, this is especially relevant because ecological concepts are relational and interconnected. Through game-based experiences, children can practise cooperation, decision-making, systems thinking, and shared responsibility. Building on these perspectives, *Growing Minds* was developed as a play-based educational tool that connects environmental learning with children's everyday experiences, peer interaction, and active participation.

## 3. Research Aim and Methodology

The aim of this research is to examine how a sustainable educational game can be developed through children's participation and how the co-design process can reveal broader issues within current educational practices. Rather than treating *Growing Minds* only as a final game product, the study approaches it as a practice-based case study in which children's play behaviours, intuitive responses, collaborative actions, and difficulties became central sources of design and pedagogical knowledge. This approach is informed by participatory design, which positions users as contributors to the design of tools and systems that affect them [7], [8], [9].

The methodology combined secondary research, field-based observation, activity design, prototyping, and iterative playtesting. The secondary research focused on play-based learning, participatory design, game-based education, environmental education, and early childhood learning. This stage helped define the main learning goals, themes, and skill areas of the project, including collaboration, ecological awareness, decision-making, systems thinking, communication, responsibility, and the ability to connect environmental concepts with everyday actions [12], [13], [15], [16].

The primary research phase involved working with children in different school and learning environments. The names of the schools are not specified in this paper in order to protect institutional and participant privacy. Instead, the research focuses on the observed interactions and learning situations that emerged during the process. Children participated in designed activities that allowed the researcher to observe how they understood rules, used symbols, collaborated with peers, responded to materials, completed tasks, negotiated decisions, and engaged with environmental themes.

Based on these insights, the first prototype of *Growing Minds* was developed and tested with children. During the playtesting sessions, the focus was not only on whether the game functioned correctly, but also on how children interacted with it. Their movements, questions, misunderstandings, excitement, peer communication, and problem-solving strategies were carefully observed. This process revealed gaps between adult design assumptions and children's actual learning needs, including the need for

stronger visual support, clearer rules, physical action, group participation, and sensory connection with the environment.

After the first prototype test, the design was revised according to these observations. The game mechanics, visual language, ecological icons, rules, and activity structure were adjusted to make the tool clearer, more engaging, and more pedagogically relevant. A second testing cycle then examined whether the revised game could better support the targeted skills and learning goals. In this sense, the methodology was both design-oriented and educational: co-design was used not only to improve the game, but also to understand how children can engage with sustainability through action, play, collaboration, and real-life tasks.

#### 4. Alternative Learning Models and Educational Outcomes

Before entering the field, the development of *Growing Minds* began with a secondary research phase focused on sustainability education, play-based learning, participatory design, and alternative educational approaches. This stage helped define the learning goals and skill areas that would guide the design process. The aim was not only to create a game about sustainability, but to understand how an educational tool could support children's participation, collaboration, ecological awareness, and skill development.

A key starting point was the role of education within sustainable development. UNESCO frames education as both a specific Sustainable Development Goal and a wider driver of social and ecological transformation [15]. This connects directly to SDG 4, which emphasizes inclusive and equitable quality education and lifelong learning opportunities. For *Growing Minds*, this supported the idea that environmental education should not only provide sustainability-related information, but should also help children practise responsibility, cooperation, decision-making, and ecological thinking through meaningful learning experiences.

The review of sustainable education highlighted the need to move beyond purely instructional approaches. Sterling argues that sustainable education requires more participatory, systemic, and transformative forms of learning [16]. This was important for the project because concepts such as ecosystems, interdependence, resources, and collective action can remain abstract when taught only through verbal explanation. Therefore, *Growing Minds* was designed around action-based learning, allowing children to learn through observing, collecting, matching, discussing, deciding, and solving problems together.

The project was also informed by experiential and constructivist learning theories. Dewey emphasizes the importance of experience and reflection in meaningful education [1], while Piaget and Vygotsky show that children actively construct knowledge through interaction with materials, peers, and social environments [2], [3]. This perspective shaped the project's attention to children's movements, choices, hesitations, misunderstandings, and peer interactions as meaningful signs of how learning takes place. Play-based and game-based learning further shaped the project. Play was approached as a serious educational method through which children explore ideas, test possibilities, negotiate rules, and express understanding through action. Game-based learning literature suggests that games can strengthen motivation and engagement through goals, rules, challenge, feedback, imagination, and social interaction [12], [13]. Recent research also supports the value of well-designed games for children's cognitive, social, and learning outcomes in early childhood education [14].

The Reggio Emilia approach provided another important reference point by framing children as capable and expressive meaning-makers whose understanding can appear through multiple forms of expression [4]. This supported the decision to observe children's learning through drawing, arranging, touching, moving, storytelling, collaboration, and play. Participatory design and co-design literature also informed the methodology, emphasizing that users should help shape the tools and systems that affect them [7], [8], [9]. In *Growing Minds*, this meant positioning children not only as users of the game, but as contributors whose behaviours and responses could guide its development.

From this secondary research, several core learning goals were identified: collaboration, communication, systems thinking, problem-solving, adaptation, responsibility, sensory engagement, and self-driven action. These skills were connected to sustainability learning and to the needs of early childhood education. The secondary research therefore created an initial framework, which was later tested and refined through field observation with children.

#### 5. Field Observations and Identified Skill Gaps

The field phase of *Growing Minds* was conducted to understand how children engage with learning tasks, environmental concepts, classroom routines, peer interaction, and play-based activities in real educational settings. The purpose was not only to test whether the game idea could function, but to observe how children learn, where they hesitate, and which skills require stronger support in early learning environments. Classroom observation, outdoor exploration, nature-based tasks, visual matching, drawing, print-making, and group-based play were used to examine how children responded to different learning situations.

The observations showed that children engaged more actively when learning was connected to movement, sensory experience, visual references, and collaborative tasks. Outdoor activities created visible curiosity and excitement, especially when children explored their surroundings, collected natural materials, and used them in creative activities. These moments suggested that environmental learning becomes more meaningful when children can physically and emotionally connect with the subject. However, the fieldwork also revealed that children often needed support in connecting abstract ideas, understanding ecological relationships, and working collaboratively rather than individually.

In classroom settings, children's learning was strongly shaped by the clarity of the task, the organization of the environment, and the teacher's guidance. Group learning became more visible when shared goals and rules were clear. However, individual work often continued even within group activities, showing that collaboration cannot be assumed simply because children are placed together. It needs to be intentionally designed through turn-taking, shared responsibilities, communication, and collective outcomes.

The first prototype testing also showed that children were able to match images and colours, but needed more support in understanding deeper relationships between categories, ecosystems, and environmental consequences. In the hexagon-based activity, children could recognize visual similarities, yet they did not always explain why certain elements belonged together or how one environmental element might affect another. This became an important design insight: *Growing Minds* needed to move beyond recognition and matching toward relational and systems thinking.

These observations helped identify the main skill gaps that the game needed to address. The skill areas were not chosen only through theory; they emerged from the combination of secondary research and direct field observation. The literature helped define the educational importance of these skills, while the fieldwork showed how they appeared in children's actual behaviours. In this sense, the game was shaped not only by adult assumptions, but by observing what children needed in order to participate more actively, understand more deeply, and connect environmental knowledge with action.

**Table 1.** Main skill gaps and their translation into *Growing Minds* game actions. It summarizes the five main skill gaps identified during the fieldwork and how they were translated into play-based design response

Identified skill gap	Field observation	Growing Minds design response
Collaboration and collective consciousness	Children sometimes worked individually even when placed in groups.	Shared missions and group outcomes were added to encourage cooperation and collective responsibility.
Visual connection-making	Children needed visual references to connect stories, categories, and ecological ideas.	Ecological icons, image cards, colour systems, and visual prompts were used to support conceptual links.
Systems thinking	Children could recognize separate images, but struggled to understand deeper ecological relationships.	Hexagon-based connections and environmental themes helped children see relationships between natural elements.



Problem-solving and adaptation	Children engaged more when they could test, repeat, adjust, and physically interact with materials.	Game challenges were designed around trial-and-error, flexible thinking, and active problem-solving.
Self-driven and peer-supported learning	Some children waited for adult direction, but became more active when encouraged to ask and learn from peers.	Structured choices, group tasks, and peer discussion moments encouraged initiative, confidence, and shared learning.

The findings from the fieldwork shaped *Growing Minds* as a game structured around skills, phases, and environmental themes. The main skill areas included collaboration, systems thinking, problem-solving, adaptation, and self-driven learning. The environmental themes included food and agriculture, water, and life on land, allowing children to approach sustainability through familiar and concrete subjects rather than distant or abstract concepts. The game structure therefore moved from local observation to broader ecological understanding and reflection.

The testing process also showed the importance of play-based learning as a research and design method. Play allowed children to engage with complex ideas through action rather than abstract explanation alone. When children moved, collected, matched, painted, discussed, and tested ideas together, learning became visible through behaviour. Their actions showed where the activity supported understanding and where the design needed to change. For example, the need for stronger visual references, clearer connection-making, and more structured collaboration directly informed the revision of the game.

For teachers, *Growing Minds* offers a practical way to introduce sustainability-related skills without relying only on verbal explanation or textbook-based instruction. The game provides visual materials, structured activities, collaborative missions, and adaptable learning themes. In this way, it helps teachers create situations where children can practise environmental thinking through play, action, peer interaction, and shared problem-solving.

## 6. Growing Minds as a Tool for Children and Teachers

After the secondary research and field observation phases, the next step was to translate the identified learning goals and skill gaps into the structure of *Growing Minds*. The design challenge was to connect sustainability-related curriculum themes with play-based actions that children could understand, practise, and build upon together. In this sense, the game was developed not only as an environmental learning tool, but also as a structured play experience supporting systems thinking, adaptation, problem-solving, collaboration, ecological awareness, and self-driven learning. This approach connects to sustainable education, participatory design, and game-based learning, which emphasize active participation, experiential learning, and social interaction [8], [12], [13], [15], [16].

The game begins with children engaging directly with their surroundings. Rather than starting from abstract information, children observe nature, collect natural elements, and use these findings as the starting point of the activity. This connects learning to place, material experience, and adaptation. From this central point, children gradually create a larger visual and conceptual map. A leaf, fruit, animal, seed, or natural object is therefore not treated as an isolated item, but as part of a wider ecological system. This supports experiential and constructivist learning, where knowledge develops through action, reflection, and interaction with the environment [1], [2], [3].

Collaboration is embedded into the mechanics of the game. Once one child places a piece, the next child needs to respond to what has already been placed by another member of the group. Children cannot follow only an individual plan; they must observe, adapt, and continue from their peers' decisions. In this way, collaboration becomes a physical and visible action rather than an abstract educational aim. The game also supports adaptation, because children may need to change direction when another player adds a different element to the shared map.

During field activities, the game also encouraged communication and peer learning. When children could not immediately identify a fruit, plant, animal, or natural element, they began asking one another instead of waiting only for the teacher to provide the answer. This showed a shift from teacher-dependent

learning toward peer-supported discovery. Through the game, children had a reason to speak, compare, explain, and help each other. This supported confidence as well as collaboration, because knowledge was created through shared exploration.

The curriculum connection is built through environmental themes such as food and agriculture, water, and life on land. These themes are concrete enough for young children to understand through everyday examples, while also introducing wider sustainability questions. Through play, children explore how plants, animals, natural resources, human choices, and environmental conditions are connected. This allows sustainability learning to become active and accessible rather than distant or abstract.

**Table 2.** Translation of *Growing Minds* game actions into skill development.

Game action	Skill developed	Educational meaning
Collecting from nature	Adaptation and sensory engagement	Children begin from their real surroundings rather than abstract content.
Creating a shared map	Systems thinking	Children see how natural elements connect within a bigger ecological picture.
Building on another child's move	Collaboration and adaptation	Children respond to peer decisions and continue a shared structure.
Asking peers about unknown items	Communication and confidence	Children learn from each other instead of depending only on the teacher.
Changing direction during play	Flexibility and problem-solving	Children practise adjusting their plan when the game situation changes.

In this sense, *Growing Minds* translates curriculum-based learning goals into play-based actions. Systems thinking becomes mapping and connecting; collaboration becomes building on another child's move; adaptation becomes changing direction according to the shared game situation; and ecological awareness becomes recognizing relationships between natural elements. These skills are not taught separately from the game, but are practised through the act of playing.

The value of *Growing Minds* also lies in how it changes the learning relationship between children, peers, teachers, and the environment. Children are not positioned only as receivers of information; they are learners who become explorers, contributors, and co-builders of the learning process. The teacher's role also shifts from being the only source of knowledge to becoming a guide who supports observation, discussion, group decision-making, and reflection. In this way, *Growing Minds* offers teachers a structured but flexible tool for introducing sustainability-related learning through visual materials, group missions, nature-based tasks, and curriculum-related themes.

## 7. Conclusion

This paper examined *Growing Minds* as a practice-based case study showing how co-design with children can support the development of sustainable educational tools for early childhood education. The project began with secondary research on sustainable education, play-based learning, participatory design, and game-based learning, which helped define the main learning goals and skill areas of the game. These included collaboration, systems thinking, adaptation, problem-solving, ecological awareness, sensory engagement, and self-driven learning [12], [13], [15], [16].

The field observations and prototype testing showed that children engage more meaningfully with environmental concepts when learning is connected to action, movement, visual references, peer

interaction, and direct experience with nature. The process also revealed several gaps within conventional educational settings. Children often needed stronger support in connecting abstract concepts, working collaboratively, understanding ecological relationships, and acting with confidence without depending only on teacher confirmation. These findings support the idea that sustainability education should not be limited to transmitting information, but should create situations where children can practise responsibility, cooperation, observation, and decision-making through active learning experiences [1], [3], [15], [16].

Through the development of *Growing Minds*, these educational needs were translated into play-based actions. Collecting natural elements, creating shared maps, building on peers' decisions, asking questions, and adapting to the direction of the game changing constantly allowed children to experience learning as a social and exploratory process. In this way, the game made skills such as collaboration, systems thinking, communication, and problem-solving visible through play. Co-design was therefore not only a method for improving the game, but also a way of understanding how children learn and what educational structures can better support them [7], [8].

The study suggests that play-based educational tools can support both children and teachers. For children, *Growing Minds* offers a way to explore sustainability through curiosity, movement, peer learning, and shared discovery. For teachers, it provides a structured but flexible tool for introducing environmental themes through classroom, garden, or outdoor activities. The teacher does not remain the only source of knowledge; instead, the game creates a learning environment where children can observe, discuss, test, compare, and learn from one another. This reflects the value of social learning, participatory learning, and game-based engagement in early education [3], [12], [13], [14].

Overall, *Growing Minds* demonstrates that sustainable education can become more meaningful when it is designed through children's participation and translated into concrete, collaborative, and playful actions. While this study does not claim to measure long-term behavioural change, it shows how field observation and co-design can reveal important educational needs and transform them into practical learning experiences. Future development of the project could include further testing in different school contexts, closer collaboration with teachers, and longer-term observation of how play-based tools support children's ecological understanding and participation over time.

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