Co-creation, Creative Expression, and Artificial Intelligence for the Inclusion of Individuals with Intellectual Disabilities

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Abstract. *This paper investigates the integration of creative computing and accessible technologies to support the digital inclusion of individuals with intellectual disabilities. We conducted participatory workshops combining visual programming (Scratch), tangible interaction (Makey Makey), and multimodal content generated with Artificial Intelligence. Fifteen participants interacted with educational games designed to connect abstract concepts with concrete physical actions. Data were collected through structured observation and analyzed using exploratory thematic analysis. Results indicate patterns of increased engagement, social interaction, and progressive autonomy, particularly in activities combining tangible interaction and multimodal feedback. The study also highlights the role of iterative co-creation, human mediation, and AI-assisted content adaptation in supporting participation across diverse cognitive profiles.*

1. Introduction

Individuals with intellectual disabilities continue to face significant barriers in accessing and using digital technologies. These barriers are technological, educational, and social in nature, including inaccessible interfaces, a lack of adapted pedagogical resources, and limited availability of trained professionals to support digital learning processes [Chadwick et al. 2013]. As a result, restricted access to technology limits opportunities for learning, expression, autonomy, and full social participation. In this context, digital inclusion extends beyond access to devices, emerging as a matter of social equity [Carey et al. 2005]. Enabling individuals to interact with technology in creative, meaningful, and autonomous ways supports cognitive, social, and artistic development, while also strengthening self-esteem and a sense of belonging.

Recent public policies in Brazil have emphasized the importance of introducing computational practices from early education, promoting creativity, computational thinking, and problem-solving skills [Conselho Nacional de Educação 2022]. At the same time, advances in Generative Artificial Intelligence (GenAI) have expanded possibilities for creating digital content, enabling the automated production of text, images, audio, and narratives adaptable to different educational contexts [S. Guedes et al. 2024]. In learning environments, these technologies can support the development of instructional materials, language adaptation, and multimodal stimuli, contributing to more accessible and engaging educational experiences.

Despite these technological and policy advances, there is still limited research on how to integrate creative computing practices and GenAI tools into educational activities for individuals with intellectual disabilities. In particular, there is a lack of studies exploring participatory approaches to designing accessible educational technologies that combine visual programming, tangible interfaces, and multimodal digital resources to support inclusive and meaningful learning experiences.

To address this gap, this paper presents a co-creation and adaptation process of accessible digital games developed using Scratch, a visual programming language widely used in creative computing education [Resnick et al. 2009]. These games were integrated with the Makey Makey device, which enables everyday objects to function as interactive interfaces, supporting more concrete and multisensory forms of interaction. Additionally, GenAI tools were used to produce multimodal elements, including text, images, and sound effects, enhancing the clarity and engagement of the activities.

The study adopts a participatory approach grounded in Human-Computer Interaction and inclusive design principles. Its main contributions are: (i) the description of a participatory process for creating and adapting accessible digital games; (ii) the integration of visual programming, tangible interfaces, and GenAI to support tangible and multimodal interaction; and (iii) empirical evidence of increased engagement, social interaction, and progressive autonomy among participants with diverse cognitive profiles.

The remainder of this paper is organized as follows: Section 2 reviews related work; Section 3 describes the research context and methods; Section 4 presents the results; Section 5 discusses the findings; Section 6 outlines practical constraints and limitations; and Section 7 concludes the paper.

2. Related Work

Research on the digital inclusion of individuals with intellectual disabilities has grown in recent years, driven by advances in digital technologies and increasing attention to accessibility and equity in education [Chadwick et al. 2013, Boot et al. 2018, Figueiredo et al. 2019]. This body of work highlights that inclusion involves more than access to devices; it requires addressing the social, cognitive, and communicational conditions that shape technology use. In this sense, digital inclusion is closely tied to social participation and the development of autonomy [Bigby and Wiesel 2011].

2.1. Educational Games and Digital Inclusion

Educational digital games have been widely recognized as effective tools for supporting learning among individuals with intellectual disabilities [Dutra et al. 2022, Papert 1980]. These environments provide structured, interactive, and visually engaging experiences that encourage experimentation and trial-and-error learning, while supporting the development of cognitive skills such as attention, memory, and pattern recognition [von Wangenheim et al. 2014].

Beyond cognitive benefits, the playful nature of games contributes to increased motivation and engagement. Accessible game design also enables more active interaction with digital systems, fostering new forms of expression and strengthening users' confidence in technology use. As a result, such experiences can promote greater autonomy and more meaningful learning outcomes [Carey et al. 2005, Brito et al. 2018].

2.2. Assistive Technologies and Inclusive Educational Environments

Assistive technologies play a central role in reducing barriers imposed by conventional digital interfaces in inclusive education contexts. Solutions that integrate physical and digital elements enable more flexible and personalized interaction, allowing adjustments in control mechanisms, pacing, and sensory stimuli according to individual needs [Boot et al. 2018, Ellis et al. 2021]. This adaptability is particularly relevant for supporting the participation of individuals with intellectual disabilities in technology-mediated learning activities.

Recent studies emphasize that accessible educational environments should be designed with usability, visual clarity, immediate feedback, and multisensory interaction in mind from the outset [Guerreiro et al. 2020, Preece et al. 2002]. In this context, there is a growing body of work focused on developing educational technologies specifically tailored to individuals with intellectual disabilities, highlighting the importance of aligning technological design with inclusive pedagogical practices [Guedes et al. 2024b].

2.3. Participatory Design and Co-creation

Participatory design approaches [Schuler and Namioka 1993, Preece et al. 2002] have been widely adopted in the development of inclusive digital technologies. This perspective emphasizes the active involvement of end users throughout the design, development, and evaluation process [Bircanin et al. 2021, Guedes et al. 2024b], ensuring that systems are aligned with users' needs, capabilities, and interaction practices.

Research on participatory design and assistive technologies for individuals with intellectual disabilities indicates that co-creation contributes not only to the technical quality of developed solutions, but also to user agency, autonomy, and sense of belonging [Bircanin et al. 2021, Guedes 2024, Guerreiro et al. 2020]. Actively involving participants in the creative process also fosters more horizontal relationships between developers, educators, and users, resulting in technologies that are more accessible and meaningful [Ellis et al. 2021, Boot et al. 2018, Guedes et al. 2024a].

Within this framework, users are positioned as contributors whose experiences inform design decisions throughout the development process [Bircanin et al. 2021]. In this study, these principles were applied through the iterative adaptation of games based on interactions observed during the workshops, characterizing a situated co-creation process aligned with participants' needs.

2.4. Generative Artificial Intelligence in Inclusive Educational Contexts

Recent advances in Artificial Intelligence, particularly generative models, have expanded the possibilities for creating and adapting digital content in educational contexts [Ray 2023, Lo 2023]. These technologies enable the automated generation of text, images, audio, and narratives, supporting the development of materials that can be adapted to different learning needs [Ray 2023].

In inclusive education, GenAI has been explored as a tool for adapting instructional content, simplifying language, and producing multimodal stimuli that support comprehension for learners with diverse cognitive profiles [Vicari et al. 2023, Giraffa and Khols-Santos 2023]. By enabling personalization and multimodal representation, these technologies can support more accessible and engaging learning experiences.

In addition, Artificial Intelligence (AI) tools can assist educators and developers in producing interactive materials, reducing barriers to content creation and enabling greater experimentation in technology-mediated learning environments [Arruda 2024, Luckin 2018]. However, there is still limited research on the use of GenAI in co-creation and creative expression activities involving individuals with intellectual disabilities, particularly when combined with participatory approaches and accessible interaction technologies [Guedes 2024].

3. Methodology

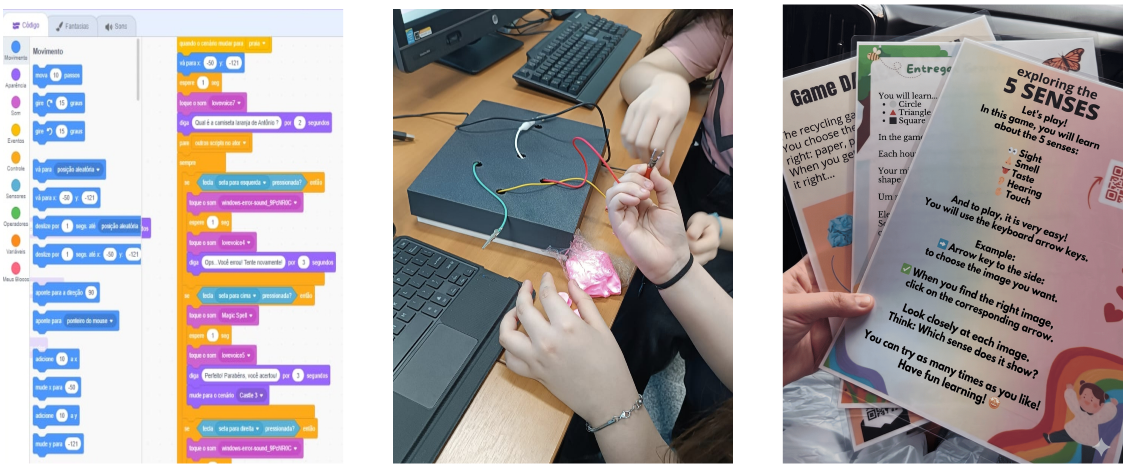
This study adopts a qualitative, exploratory approach based on direct observation of participant interactions and the development of accessible technological resources for individuals with intellectual disabilities. The methodology emphasized inclusive and participatory practices, taking into account the cognitive, motor, and sensory characteristics of the target group. Throughout the project, the research team conducted regular meetings for planning, development, and evaluation, enabling continuous monitoring and iterative refinement of the proposed activities and technologies.

Following approval from the ethics committee, technical visits were conducted at a partner institution specialized in supporting individuals with intellectual disabilities. These visits aimed to understand the institutional context, observe participants' everyday interactions, and identify educational and sensory needs in an ethical and systematic manner. Insights from this stage informed the selection of technological tools, the definition of workshop themes, and the adaptations required to improve accessibility and comprehension.

Based on these initial observations, a set of interactive games was developed using the Scratch platform and later integrated with the Makey Makey device. Scratch was selected for its visual programming environment, which provides an intuitive and accessible interface widely adopted in creative computing activities [Guedes et al. 2024a]. An example of the development interface is shown in Figure 1a.

In total, four main games were created and iteratively refined throughout the workshops based on participants' interactions. To support more concrete and accessible forms of interaction, the games were connected to Makey Makey, enabling physical objects to function as input controls. Figure 1b illustrates a controller built with conductive playdough, allowing interaction through manipulable objects and accommodating different levels of motor ability. Additionally, Figure 1c presents the instructions used in the activities, designed in Easy Read format (illustrated in English) to support comprehension.

The themes addressed in the games were defined in collaboration with the project supervisor, a specialist in the field. Topics were selected based on their relevance to participants' daily experiences, aiming to support the understanding of concepts encountered in everyday life. These included basic geometric shapes, the human senses, waste disposal, and self-care activities such as tooth brushing. Grounding the activities in familiar contexts helped make the learning experience more meaningful and accessible.



(a) Scratch (b) Makey Makey (c) Instructions

Figure 1. Integration of visual programming in Scratch, physical interaction using Makey Makey, and the instructions of the developed games.

During the testing and implementation phases, the Makey Makey device played a central role in mediating interaction between participants and digital games. It enabled the creation of customized and alternative input mechanisms using conductive materials, particularly modeling clay, which was widely adopted due to its ease of manipulation and flexibility in constructing interactive objects. This approach allowed physical artifacts to function as control interfaces, supporting participation among individuals with motor limitations or difficulties using conventional input devices such as keyboards and mice.

In addition, 3D printing was used to produce physical objects designed for interaction with the games. Custom models were created to complement digital activities and expand opportunities for tangible interaction. For example, in a recycling-themed game, small bins representing different types of waste were printed and used alongside Makey Makey and clay-based elements. This setup simulated real-world disposal practices while reinforcing the visual and conceptual aspects of the activity.

GenAI tools were also incorporated to support the creation of multimodal game elements. Technologies such as ElevenLabs, Gemini, and ChatGPT were used to generate audio narratives, images, and textual content for interfaces and instructions. These resources helped make the materials clearer and more engaging, enabling the design of visual and auditory stimuli tailored to the characteristics of the participants.

3.1. Participants

The study involved fifteen volunteers enrolled in APAE, a Brazilian institution that provides support services for individuals with intellectual disabilities. Participants ranged in age from 18 to 48 years and all had a formal diagnosis of intellectual disability. Specific diagnostic details were not available to the research team, as they were outside the scope of the study. However, the institution indicated that some participants had associated comorbidities. The group was heterogeneous in terms of communication abilities, levels of autonomy, and responses to sensory stimuli, including non-verbal participants.

Multiple workshops were conducted throughout the project, with selected sessions reported here as representative examples. Activities took place in group settings within the institution, providing a familiar environment that reduced adaptation barriers and encouraged spontaneous participation. According to staff observations, participants demonstrated higher levels of interest and engagement compared to traditional approaches. Interactive and multisensory resources were particularly effective in sustaining attention and involving individuals who typically showed lower engagement as confirmed in previous studies [Ellis et al. 2021, Guedes et al. 2023, Guedes et al. 2025]. GenAI tools were also used to support the workshops, assisting in the creation of adapted content and contributing to more accessible activities for participants with diverse communication needs.

3.2. Instruments and Data Collection

The primary instruments used in this study consisted of interactive games developed in Scratch and operated through the Makey Makey device, complemented by visual, auditory, and textual elements generated with the support of GenAI tools. These technologies were used to create images, sound effects, and simplified textual content, contributing to materials that were more accessible and better aligned with participants' cognitive profiles.

Data collection was conducted through structured qualitative observation of participants' interactions during the workshops. Observations focused on attention levels, engagement, understanding of instructions, emotional responses, and any motor or sensory difficulties observed throughout the sessions. All records were descriptive in nature and aimed at capturing the collective experience to inform iterative improvements. No personal or identifiable data were collected.

Interactions were documented through structured observation carried out by researchers present during the activities. A protocol guided data collection based on three dimensions: (i) attention during activities, (ii) engagement with the games, and (iii) level of autonomy in task execution. Each dimension was qualitatively assessed using observable indicators such as initiative, need for assistance, and responsiveness to visual and auditory stimuli.

Field notes were recorded after each session and later organized for analysis. The data were examined using exploratory thematic analysis, allowing the identification of recurring patterns related to interaction, engagement, and comprehension.

The development of the games followed an iterative design process informed by these observations. Early interactions with participants, particularly during the initial sessions, revealed the need to adapt the original artifacts to improve accessibility. This led to a series of refinements guided by direct user feedback, characterizing a co-creation approach.

For example, initial versions of the games used generic clay controls, which led to confusion in associating physical actions with on-screen responses. This issue was addressed by redesigning the controls as arrows and color-matching them with interface elements, significantly improving interaction clarity and reducing the need for assistance.

The iterative refinement process can also be interpreted through a scaffolding perspective [Guedes et al. 2024b], in which tasks, interfaces, and feedback mechanisms were progressively adjusted to support participants' understanding and interaction.

Support strategies were gradually modified according to participants' responses, enabling increasing levels of autonomy over time.

From a visual and cognitive perspective, graphical elements were simplified to reduce sensory overload and support focus on core tasks. Multimodal feedback was introduced to reinforce understanding, combining text, audio narration, and distinct sound effects to indicate correct and incorrect actions.

Interaction mechanics were also refined. Task difficulty was adjusted to support progression, and game structures were modified to reduce repetitiveness and sustain engagement. A key adaptation involved the tangible interface: modeling clay controls were shaped as arrows and color-matched with on-screen elements in Scratch. This direct mapping between physical objects and digital controls significantly improved cognitive and motor association, highlighting the role of adaptive design in inclusive learning contexts.

The use of GenAI for multimodal content production required careful contextualization and evaluation. Prompt engineering techniques were employed to tailor outputs to the target audience, explicitly specifying the need for simple, direct language and avoiding abstract or metaphorical expressions. For visual content, prompts emphasized clarity and minimal visual complexity to reduce cognitive load.

All AI-generated materials were critically reviewed by the research team in collaboration with the project supervisor. Internal testing was conducted prior to deployment in workshops, and content was only incorporated when it met established accessibility criteria. When outputs were unsuitable, prompts were refined and regenerated, resulting in an iterative curation process aligned with the project's accessibility goals.

3.3. Ethical Considerations

This study was conducted in accordance with ethical guidelines for research involving human participants and was approved by the Research Ethics Committee under Opinion Number 8.026.109 (CAAE: 91883925.8.0000.0199), issued by Anhanguera–Uniderp. The project also received local authorization from the partner institution (APAE), where the activities were carried out.

Participation was voluntary and required both institutional authorization and informed consent from participants' legal guardians. Throughout all activities, participants were accompanied by professionals from the institution, ensuring appropriate conditions of safety, support, and well-being.

Workshops were conducted in group settings, following the institution's regular routines. Despite the collective format, confidentiality was strictly maintained: all data are presented in aggregated form, with no information that could enable individual identification. The study was designed and conducted with a strong emphasis on inclusion, accessibility, and respect for participants' abilities. Participants were free to withdraw at any time without any negative consequences.

4. Results

Throughout the workshops, participants demonstrated progressive changes in their interaction with digital technologies and engagement in the proposed activities. In the initial sessions, many participants showed hesitation when interacting with technological resources. Over time, they began to use Scratch, Makey Makey, and AI-based resources with greater confidence and reduced need for assistance.

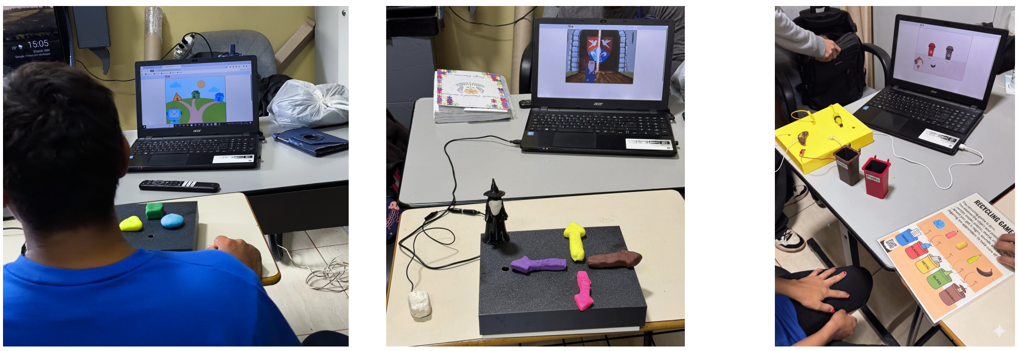
The combination of visual programming and tangible interfaces was associated with changes in how participants interacted with the system. Participants manipulated sensors connected to Makey Makey and observed corresponding responses in Scratch-based games, exploring the relationship between physical actions and digital outcomes. This interaction model was used by participants with different levels of motor ability.

Exploratory behaviors were observed throughout the workshops. Participants increasingly initiated repeated interactions, tested different inputs, and engaged with the system using alternative interaction strategies. These behaviors became more frequent over successive sessions, particularly in activities involving direct manipulation of physical elements.

Changes in social interaction were also observed. Participants who were initially more reserved began to interact more frequently with researchers and peers during the activities. Professionals from the institution reported higher levels of engagement and sustained attention compared to routine activities, particularly among participants who typically demonstrate lower participation.

A representative example was observed in an early workshop session, in which four participants interacted with two educational games developed in the project. The first game focused on recognizing basic geometric shapes (Figure 2a). The activity combined visual stimuli, narrated instructions, and manipulable physical objects, allowing participants to associate on-screen elements with tangible representations. Physical components—including a 3D-printed character and clay-based controls connected to Makey Makey—were used as input mechanisms.

The second game addressed the five senses (Figure 2b). During this activity, higher levels of attention and more immediate responses were observed, particularly in stages involving auditory stimuli.



(a) Geometric shapes (b) Five senses (c) Recycling

Figure 2. Examples of games developed and used during the workshops.

The co-creation process revealed practical challenges during implementation. The use of GenAI tools required multiple iterations to obtain suitable outputs, as generated content frequently needed refinement to meet clarity and accessibility requirements.

Challenges were also observed in the tangible interaction setup. While Makey Makey and modeling clay enabled alternative forms of input, the clay lost conductivity over time and required frequent adjustment during activities.

The heterogeneity of participants in terms of age, motor abilities, and communication skills required continuous adaptations during the workshops. Differences were observed in task execution pace, need for assistance, and levels of autonomy.

Auditory feedback was used throughout gameplay to signal system responses. Participants reacted to these feedback cues during task execution, maintaining attention and continuing interaction with the activities.

In the geometric shapes game, clay objects were shaped according to the figures displayed on screen, allowing participants to interact through direct physical manipulation. In addition, GenAI-supported resources were used to generate multimodal elements such as sound effects, images, and short textual prompts, which were incorporated into the games.

Table 1 presents observations from the geometric shapes and five senses games, detailing participant behavior in terms of engagement, task execution, and responsiveness to multimodal elements.

Participant	**Geometric Shapes Game**	**Five Senses Game**
Participant 1	Non-verbal. Initially hesitant, but understood the interaction model and performed tasks accurately, responding positively to auditory feedback.	Demonstrated increased confidence and faster responses, completing the activity with minimal guidance in the final stage.
Participant 2	Non-verbal. Showed interest despite initial difficulty recognizing shapes, eventually completing the interactions successfully.	Displayed higher engagement, with clear positive responses to auditory stimuli.
Participant 3	Quickly understood the game dynamics and completed all tasks independently.	Initiated interaction voluntarily and completed all stages autonomously.
Participant 4	Highly engaged. After initial instructions, completed all tasks accurately.	Participated enthusiastically and completed the activity independently.

Table 1. Summary of participant interactions in the geometric shapes and five senses games, highlighting engagement, comprehension, and autonomy.

Analysis of the observational data identified three recurring patterns of participation: (i) participants who performed tasks autonomously after initial exposure; (ii) participants who required initial guidance but completed tasks with minimal support; and (iii) participants who required longer adaptation periods during early interactions. These patterns were also observed in a later activity focused on environmental awareness (Figure 2c, translated with AI support), in which participants were asked to match different types of waste with the appropriate bins. The setup integrated clay-modeled objects representing waste, 3D-printed bins, and a Scratch-based game, complemented by a short instructional guide.

Interaction occurred through clay-based objects connected to Makey Makey, allowing participants to make selections through physical manipulation. The system provided immediate feedback: incorrect selections produced no response, while correct selections triggered an audio cue and progression to the next stage.

The activity involved eleven participants with varying levels of autonomy, all of whom completed the task, although some required initial guidance, particularly in identifying the correct bins. Instances of social interaction were also recorded, with participants receiving feedback from peers and educators, including verbal encouragement and applause following task completion. Table 2 summarizes these observations, highlighting variations in engagement, task execution, and levels of independence.

Participation was observed across activities involving shape recognition, sensory association, and waste classification, with varying levels of support. Task completion was observed under different levels of support, with participation occurring across diverse cognitive and motor profiles.

5. Discussion

5.1. Engagement, Autonomy, and Progressive Participation

The progression from initial hesitation to more independent interaction reflects a gradual process of engagement with digital technologies. Early sessions were characterized by reliance on guidance, whereas later interactions included repeated attempts, self-initiated actions, and reduced need for assistance. This pattern aligns with perspectives from creative computing, where learning is structured through exploration and iterative engagement rather than immediate task mastery [Papert 1980, Resnick et al. 2009]. In this context, engagement is not limited to successful task completion, but also includes persistence, repetition, and voluntary interaction, which have been discussed in prior work [Brennan and Resnick 2012].

These observations are also consistent with studies on digital inclusion that emphasize participation as a process shaped by access, familiarity, and interaction opportunities [Boot et al. 2018]. Rather than a binary condition, participation emerges progressively as users appropriate technologies in ways that are meaningful within their context [Figueiredo et al. 2019]. In the workshops, this progression was observable through increased initiative and sustained interaction over time.

5.2. Tangible and Multimodal Interaction in Supporting Comprehension

The integration of tangible interfaces influenced how participants engaged with digital systems. By enabling direct manipulation through physical artifacts, the

Participant	Recycling Game
Participant 5	Attentive and engaged. Correctly identified the appropriate bins; initial hesitation was overcome with support, leading to successful task completion and positive engagement.
Participant 6	Highly attentive and enthusiastic. Quickly understood the game dynamics and interacted with confidence and ease.
Participant 7	Maintained focus on waste classification. After an initial error and brief guidance, demonstrated correct understanding and interest in the tangible elements.
Participant 8	Motivated to complete the task accurately. Initial hesitation decreased over time, resulting in improved performance with minimal support.
Participant 9	Actively engaged, including verbal interaction. Demonstrated gradual understanding; initial difficulties in identifying bins were resolved with guidance.
Participant 10	Consistently attentive and participative. Performed well overall, with occasional uncertainty addressed through encouragement.
Participant 11	Understood the game mechanics and remained motivated. Learned from errors and improved performance following guidance.
Participant 12	Demonstrated clear understanding of the activity and persistence in completing the tasks.
Participant 13	Maintained consistent attention. With additional explanation, successfully completed the classification tasks.
Participant 14	Showed enthusiasm and satisfaction throughout the activity. Positive reinforcement contributed to sustained engagement.
Participant 15	Highly engaged, interacting actively and showing strong interest in the hands-on experience.

Table 2. Summary of participant performance in the recycling game, highlighting engagement, comprehension, and progression during the activity.

activities reduced reliance on abstract representations and allowed participants to act through concrete interaction. This design approach is consistent with findings by [Shaer and Hornecker 2010], who highlight the role of tangible interfaces in bridging physical and digital domains, and by [Ellis et al. 2021], who emphasize their relevance in inclusive educational settings.

Multimodal feedback also played a role in shaping interaction. Auditory cues, combined with visual elements, provided immediate responses during task execution, supporting continuity of interaction. According to [Preece et al. 2002], multimodal systems can improve accessibility by distributing information across different sensory channels. Similarly, [Guerreiro et al. 2020] argue that multisensory interaction contributes to usability and comprehension in accessible systems. In this study, participants responded to these cues during interaction, particularly in activities involving sound-based stimuli.

5.3. Co-creation, Iteration, and Scaffolding Processes

The iterative adaptation of the games throughout the workshops reflects a co-creation process grounded in participatory design principles, as described by [Schuler and Namioka 1993]. Rather than being predefined artifacts, the games were continuously modified based on observed interaction patterns, aligning with approaches that position users as contributors in the design process [Bircanin et al. 2021].

This iterative process can be interpreted through the concept of scaffolding. In educational contexts, scaffolding refers to structuring tasks and interaction conditions to support progressive understanding and gradual skill development [Guedes et al. 2024b]. In this study, adjustments such as simplifying visual elements, refining control mappings, and introducing multimodal feedback were made in response to participant needs, enabling gradual adaptation to the interaction model.

The role of educators and researchers was central in this process. Human mediation supported comprehension of instructions, guided task execution when necessary, and enabled dynamic adjustments during activities. Prior work has shown that the effectiveness of accessible technologies is closely linked to contextual support and pedagogical mediation [Boot et al. 2018]. In line with [Ellis et al. 2021], this study reinforces that interaction design alone is insufficient without considering the social and instructional context in which technologies are used.

5.4. Generative Artificial Intelligence as a Mediating Resource

GenAI was used as a resource for producing multimodal content adapted to participants' needs. Its application focused on generating images, audio, and simplified textual elements, supporting the creation of materials aligned with different levels of comprehension. This use is consistent with recent studies that explore AI for content adaptation and multimodal representation in educational contexts [Ray 2023, Vicari et al. 2023].

However, the process required continuous human oversight. Generated outputs were iteratively refined through prompt adjustments and evaluation, highlighting the need for contextualization in AI-assisted design. As discussed by [Luckin 2018], AI systems in education should be understood as augmenting human capabilities rather than replacing them. Similarly, [Arruda 2024] emphasize the importance of critical use of AI tools, particularly in inclusive contexts.

In this study, GenAI functioned as part of a broader design workflow, where its effectiveness depended on its integration with pedagogical decisions and interaction design.

6. Practical Constraints and Limitations

The implementation of the workshops revealed constraints related to both technology and context. Tangible interaction, while enabling alternative forms of input, introduced maintenance challenges, such as the degradation of conductive materials and the need for frequent adjustments during activities. These issues illustrate the trade-offs involved in deploying tangible systems in real-world environments.

The use of GenAI also presents limitations. Identifying appropriate tools, refining outputs, and ensuring accessibility required additional effort, and broader concerns related to ethical use and environmental impact remain relevant in the context of AI adoption.

The heterogeneity of participants required continuous adaptation of tasks and interaction strategies. Differences in motor abilities, communication styles, and levels of autonomy limited the applicability of uniform solutions and reinforced the need for flexible design approaches.

Finally, the study is limited by its qualitative and context-specific nature. Data were collected through observation in a single institutional setting and analyzed using exploratory methods. While the findings provide insight into interaction patterns and design strategies, they and are not intended to be statistically generalizable.

7. Conclusions

This study examined how creative computing, tangible interaction, and AI-supported multimodal resources can support the participation of individuals with intellectual disabilities. The findings indicate that these elements, combined with participatory design and iterative adaptation, contribute to increased engagement, social interaction, and progressive autonomy during the activities.

The results highlight that accessible interaction emerges from the interplay between technological design, human mediation, and scaffolding processes. Educators and researchers played a central role in guiding interaction, adapting tasks, and supporting participants' understanding throughout the workshops.

This study also provides practical insights into the use of tangible interfaces and GenAI in inclusive educational contexts. These technologies expand possibilities for interaction and content creation, while their effective use depends on continuous refinement, contextual adaptation, and alignment with participants' cognitive and sensory characteristics.

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