

A UDL-BASED APPROACH TO AI CHATBOT INTERACTION FOR YOUNG ADULTS WITH INTELLECTUAL DISABILITIES

UN APPROCCIO BASATO SULL'UDL PER L'INTERAZIONE CON CHATBOT AI PER GIOVANI ADULTI CON DISABILITÀ INTELLETTIVE LIEVI



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ABSTRACT

This study proposes a protocol, grounded in Universal Design for Learning (UDL), to enhance the engagement of young adults with intellectual disabilities with an AI chatbot, used for producing interviews on Science, Women, and STEM. The methodology includes prompt co-design, ICF-based customization, and qualitative analysis. Findings aim to inform inclusive practices and critical reflections on AI accessibility.

Questo studio propone un protocollo, basato sul Universal Design for Learning (UDL), per facilitare l'interazione di giovani adulti con disabilità intellettive con un chatbot AI, impiegato nella redazione di interviste su Scienza, Donne e STEM. La metodologia prevede co-progettazione dei prompt, personalizzazione secondo ICF e analisi qualitativa. I risultati mirano a promuovere pratiche inclusive e riflessioni sull'accessibilità dell'AI.

KEYWORDS

Generative AI in Education, Universal Design for Learning, Digital Inclusion

IA Generativa in Educazione, Progettazione Universale per l'Apprendimento, Inclusione Digitale

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Introduction

In the context of inclusive education, the adoption of emerging technologies such as artificial intelligence (AI) represents not only a complex challenge but also a compelling opportunity to rethink how students with intellectual disabilities access, participate in, and benefit from educational processes. If designed with accessibility in mind, digital tools can foster autonomy, self-expression, and social inclusion. However, despite the growing ubiquity of intelligent technologies in education, these tools often lack the flexibility and responsiveness necessary to support learners with cognitive vulnerabilities. Interfaces are typically conceived from a one-size-fits-all perspective, privileging normative models of interaction that do not account for the diverse ways individuals process information, communicate, and engage with content. In response to this gap, the present case study explores the co-construction and implementation of a pedagogical protocol aimed at facilitating the interaction of young adults with intellectual disabilities with a generative AI chatbot. The chatbot is used as a virtual assistant to support the creation of interviews and editorial pieces on the theme of “Science, Women, and STEM.” The overarching objective is not merely to evaluate the technical usability of AI-based tools, but to investigate the extent to which accessible and inclusive design can enable users to take on meaningful communicative roles—as authors, not just recipients of information. The study draws upon a dual theoretical framework: Universal Design for Learning (UDL) and the International Classification of Functioning, Disability and Health (ICF). UDL, developed by CAST (2011), provides a flexible model that values learner variability and encourages the design of learning environments through multiple means of engagement, representation, and expression. In this research, UDL served as a foundation for co-designing chatbot prompts with the participants, ensuring that interactions were both cognitively accessible and pedagogically relevant. At the same time, the ICF framework (WHO, 2001) was employed to assess participants' functional profiles and customize prompts accordingly. This biopsychosocial model enabled a deep understanding of individual abilities, including cognitive, relational, and motor dimensions, while also accounting for environmental and social factors that influence learning. This integrated approach allowed for an adaptation of digital tools to learner profiles. Rather than seeing intellectual disability as a label, the study operationalizes it through functional descriptors and responsive design choices, facilitating an interaction that is both supported and empowered. Furthermore, by involving

participants in the creation of prompts, the project emphasises agency and voice, challenging traditional hierarchies that position people with disabilities as passive consumers of content. The work is part of a broader movement advocating the ethical design of AI in education, an approach that emphasizes human dignity, equity and social inclusion. In particular, it responds to the growing demand in the literature to recast AI not just as a technical improvement, but as a socially embedded practice that must be responsible for the full range of human diversity. The fusion of UDL and ICF offers a replicable model for educational settings that seek to operationalise equity through pedagogical and technological innovation. Ultimately, this study seeks to contribute to the ongoing reflection on the accessibility of widely used AI tools like ChatGPT and to offer a practical model for how such technologies can be reimagined to support inclusive, student-centered learning. It challenges dominant narratives of digital innovation by centering the needs and capacities of learners who are often excluded from mainstream digital experiences. In doing so, it affirms the transformative potential of inclusive AI when it is co-designed with and for those it aims to serve.

1. Theoretical Framework

1.1 Universal Design for Learning: Core Principles and Inclusive Educational Practices

Universal Design for Learning (UDL) represents a pedagogical framework that recognizes and values the diversity of students right from the design phase of teaching. Developed by CAST (2011), UDL proposes that accessible educational environments should anticipate learner variability and remove structural barriers to learning by design. The model is structured around three core principles: multiple means of representation (the “what” of learning), multiple means of action and expression (the “how”), and multiple means of engagement (the “why”). These principles collectively support a flexible, responsive learning environment that accommodates a broad spectrum of abilities, preferences, and cultural contexts. In the present study, UDL served both as a theoretical foundation and an applied methodology. Through participatory co-design processes, learners with intellectual disabilities collaborated with facilitators in constructing prompts to interact with a generative AI chatbot (ChatGPT). These prompts were tailored to accommodate individual language comprehension levels, processing speeds, and modes of

engagement, aiming to foster autonomy in producing editorial content. In alignment with UDL, the prompts were constructed using accessible language, supported by visual scaffolds where appropriate, and structured to allow multiple avenues for expression.

The application of the UDL approach in this context reflects recent academic discourse emphasizing the convergence of inclusive pedagogy and intelligent technologies. Hyatt and Owenz (2024) highlight the synergetic potential of integrating UDL with AI to design digital learning environments that dynamically respond to learners' evolving profiles. Similarly, Priyadharsini and Sahaya Mary (2024) argue that UDL frameworks promote not only improved learning outcomes, but also student agency and motivation—critical elements for populations that may face chronic educational marginalization. AlRawi and AlKahtani's (2022) systematic review of UDL in intellectual disability education further confirms its efficacy in improving learner participation, particularly when digital tools are used to mediate cognitive barriers. The study's reliance on UDL also responds to growing calls for ethical, human-centered AI in education. When applied to chatbot interaction, UDL provides a schema to balance technological affordances with learners' cognitive, linguistic, and emotional needs. Moreover, it encourages educators and developers to consider AI as a co-constructed medium for communication, creativity, and self-determination. In this way, UDL operates not only as a mechanism for accessibility but as a broader pedagogical philosophy that aligns with values of equity and inclusion in digital learning environments.

1.2. The ICF Framework: Understanding Individual Functioning and Accessibility Needs

The International Classification of Functioning, Disability and Health (ICF), published by the World Health Organization (2001), offers a biopsychosocial model for understanding disability and functioning in multidimensional terms. In contrast to traditional deficit-focused approaches, the ICF conceptualizes disability as the result of interactions between health conditions and contextual factors, including environmental barriers and facilitators. It encompasses multiple domains such as body functions, activity limitations, participation restrictions, and environmental support systems. As such, it serves as both a taxonomy and a planning tool for individualized educational and rehabilitative interventions. In this study, the ICF

was operationalized through the use of a structured checklist. This tool was employed during a preliminary assessment phase to evaluate each student's functional profile, including cognitive and communication abilities, fine motor skills necessary for digital interaction, and relational-motivational factors. By mapping these dimensions, it became possible to create a personalized interaction protocol with the AI chatbot. For instance, prompts were adjusted based on an individual's verbal comprehension, attentional capacity, and preferred interaction style. This implementation draws inspiration from Carruba and Covarrubias (2024), who applied the ICF checklist to tailor virtual reality training for students with special educational needs. Their work illustrates how understanding functional variation can help both pedagogical and technical design of learning activities. The present study extends this approach by applying it to AI-mediated communication, a context where even subtle mismatches between user capability and system design can lead to exclusion or failure. In particular, the distinction between "performance" and "capacity" within the ICF framework was critical: while performance denotes what a student can do in their typical environment, capacity reflects potential ability under ideal support conditions. This distinction guided the choice of prompt structure, length, and feedback loops, enabling educators to scaffold learners progressively toward more autonomous interaction. Furthermore, the use of the ICF enabled a differentiation of learning barriers and facilitators in the technological context. Environmental factors—such as device accessibility, screen layout, and peer support—were recorded and addressed within the interface and instruction plan. The approach aligns with Wehmeyer et al. (2020), who underline the importance of cognitive technologies in supporting the autonomy of people with intellectual and developmental disabilities, provided that these technologies are tailored through holistic functional profiling.

1.3. Bridging the Digital Accessibility Gap with Conversational AI Tools for Individuals with Intellectual Disabilities

Generative conversational AI models, including ChatGPT, are emerging as potentially transformative tools in education. They enable learners to explore content interactively, generate text collaboratively, and engage in real-time language modeling. However, these benefits are not equitably distributed, especially among learners with intellectual disabilities. The cognitive demands involved in interacting with such systems—comprehending open-ended prompts,

processing abstract responses, and managing multi-turn dialogues—can represent significant accessibility barriers (AbdAlgane & Elkot, 2024). Recent literature points to the need for inclusive design frameworks that adapt AI tools to diverse cognitive profiles. Mateos-Sanchez et al. (2022) developed a chatbot system specifically for individuals with intellectual disabilities, focusing on life-skills training and social interaction. Their results highlight the effectiveness of simplified language, visual guidance, and structured interaction pathways. Similarly, Jimenez et al. (2024) advocate for integrating AI tools into evidence-based teaching practices, where guided interaction scaffolds learners toward greater independence and comprehension. Pagliara et al. (2024) argue that inclusive AI must extend beyond mere usability to address systemic inequities in digital participation. In alignment with their findings, our work demonstrates that accessibility must be both functional and pedagogical, informed by continuous dialogue between users, educators, and designers. Chemnad and Othman (2024) reinforce this point by highlighting how AI research has often privileged certain disability categories (e.g., visual impairments) while neglecting cognitive and developmental disabilities. Our study responds directly to this gap, offering a replicable model for inclusive design grounded in both theory and participatory practice. Finally, the integration of UDL and ICF into conversational AI design represents a move toward ethical and equitable educational technology. By bridging the digital accessibility gap for young adults with intellectual disabilities, this approach not only enhances immediate learning outcomes but also contributes to broader goals of digital citizenship, autonomy, and inclusion in an increasingly AI-mediated world.

2. Methodology

This research adopted a qualitative case study approach focused on a specific group of young adults with mild intellectual disabilities aged between 18 and 35. The participants were selected through a convenience sampling strategy, ensuring that the project aligned with their pre-existing interests in technology and artificial intelligence. The group was part of the *Fraternità e Amicizia* social cooperative in Milan, an organization actively engaged in promoting social inclusion through personalized educational and occupational pathways.

The intervention was structured in three phases, following the Protocol for Prompting in a UDL Perspective for the Use of ChatGPT.

Phase	Description	Examples
1. Collective Prompt Design	Create clear, simple, and structured commands to facilitate understanding. Use plain language and avoid technical terms. Encourage critical thinking through guiding questions and concrete examples.	✔ Who is a famous scientist? What did she discover? ✔ Write three fun facts about a woman in STEM.
2. Personalized Prompting	Adapt prompts to individual needs using simplified language, visual/audio supports, and choice-based engagement. Allow for different output formats such as stories or lists.	✔ Tell me something about a scientist in a very simple way. ✔ Do you want to learn more about Marie Curie, Ada Lovelace or Rita Levi-Montalcini?
3. Impact Assessment	Evaluate the clarity and effectiveness of AI interaction using comprehension questionnaires and debriefing sessions. Continuously refine prompts based on feedback.	✔ Did you find the text helpful? ✔ What was difficult or easy to understand?

Table 1. UDL-Based Prompting Protocol for AI Interaction

In the first phase—Elaborazione Collettiva dei Comandi—facilitators and participants collaboratively generated simple, clear, and structured prompts. These were specifically aimed at eliciting responses from ChatGPT on the theme of 'Science, Women and STEM.' Facilitators avoided technical jargon, supported comprehension through scaffolding questions, and introduced formats such as lists and visual cues.

The second phase—Personalizzazione dei Prompt—involved adapting the prompts to each participant's functional profile, as assessed through the ICF framework. Prompt difficulty, length, and structure were tailored according to individual capacities, incorporating multimodal supports such as icons or synthetic speech when needed. Participants were also encouraged to choose among simplified prompt options, fostering active involvement and preference-based interaction.

Finally, the third phase—Valutazione dell’Impatto—focused on evaluating usability and educational impact through comprehension questionnaires, debriefing sessions, and facilitator observations. Participant feedback was systematically collected to refine both prompts and delivery strategies. This iterative process ensured that the interaction with AI was meaningful, comprehensible, and empowering for all participants. The activities were coordinated by a multidisciplinary team composed of a senior expert with a background in both technology and education, and a PhD student in training, specializing in educational research. They were supported by educational mediators regularly involved in the participants’ editorial activities. A preparatory phase of approximately two weeks preceded the intervention, during which collaborative planning sessions were held to design instructional materials, adapt chatbot prompts to the participants’ functional profiles, and select educational topics aligned with their prior knowledge and interests.

3. Data Analysis and Results

Quantitative data derived from task timing logs and SUS responses were complemented by qualitative data coded using a grounded theory approach. Coding was independently performed by two researchers and inter-rater reliability was assessed using Cohen’s Kappa coefficient, achieving a satisfactory value ($\kappa = 0.82$). Participant feedback was thematically analyzed to identify perceived benefits, challenges, and engagement patterns related to the UDL-informed AI interaction. Visual representations (Figures 1–3) further support the interpretation of emerging trends, highlighting the progressive improvement in task efficiency and perceived usability. The analysis phase aimed to evaluate the educational and cognitive impact of the UDL-based interaction protocol, focusing on both qualitative outcomes and objective performance indicators collected across the three implementation phases.

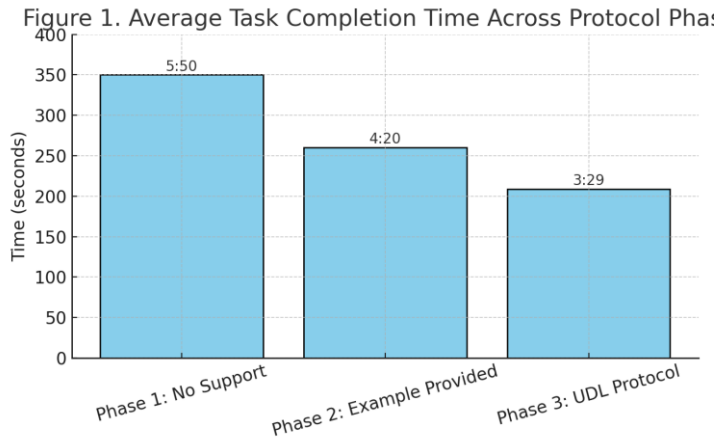


Figure 1. Average Task Completion Time Across Protocol Phases

The analysis phase aimed to evaluate the educational and cognitive impact of the UDL-based interaction protocol, focusing on both qualitative outcomes and objective performance indicators collected across the three implementation phases.

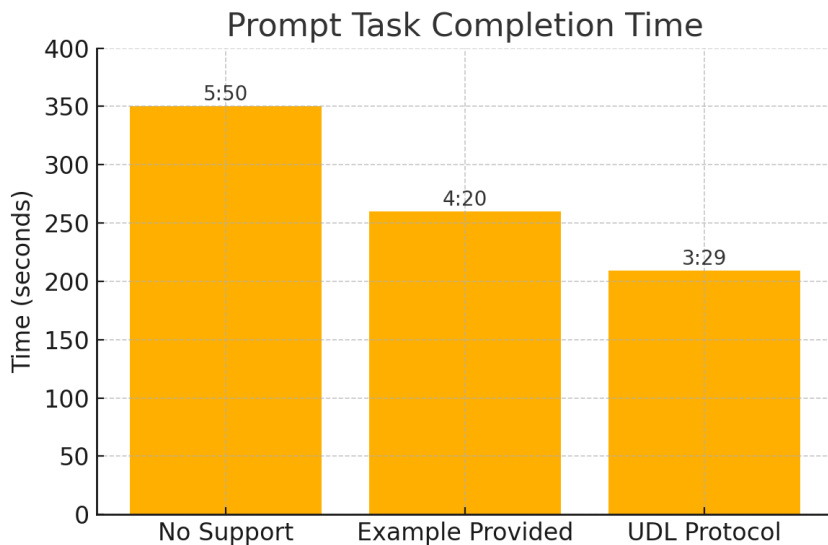


Figure 2. Comparison of average task duration across experimental phases

To further assess the perceived usability of the system, the System Usability Scale (SUS) was administered after the final phase. This validated 10-item instrument allowed participants to express agreement on key usability statements on a 5-point Likert scale. The aggregate score, computed according to standard guidelines, provided a quantitative indicator of system accessibility and learnability (Lewis & Sauro, 2017).

The data analysis was conducted through thematic coding of observation notes, participant outputs, and transcripts from debriefing sessions. A qualitative-descriptive approach was employed to identify patterns of interaction, engagement, and perceived comprehension across the three phases of the protocol.

Preliminary findings highlight a significant increase in user autonomy and expressive agency. Most participants demonstrated the ability to formulate simple questions and interpret responses from ChatGPT with minimal facilitator mediation. The use of co-designed and personalized prompts contributed to greater clarity and sustained attention during the activity sessions.

Moreover, the multimodal supports—such as visual scaffolds and simplified syntax—enabled participants to engage more confidently with abstract STEM-related content. Notably, users with lower verbal comprehension showed improved interaction when offered choices in the form of multiple-choice prompts or supported reading aloud via text-to-speech.

The SUS scores recorded from participants show a consistently high perception of usability. All scores surpass the standard threshold of 68, indicating effective interaction with the AI system.

Figure 3. System Usability Scale (SUS) Scores of Participants

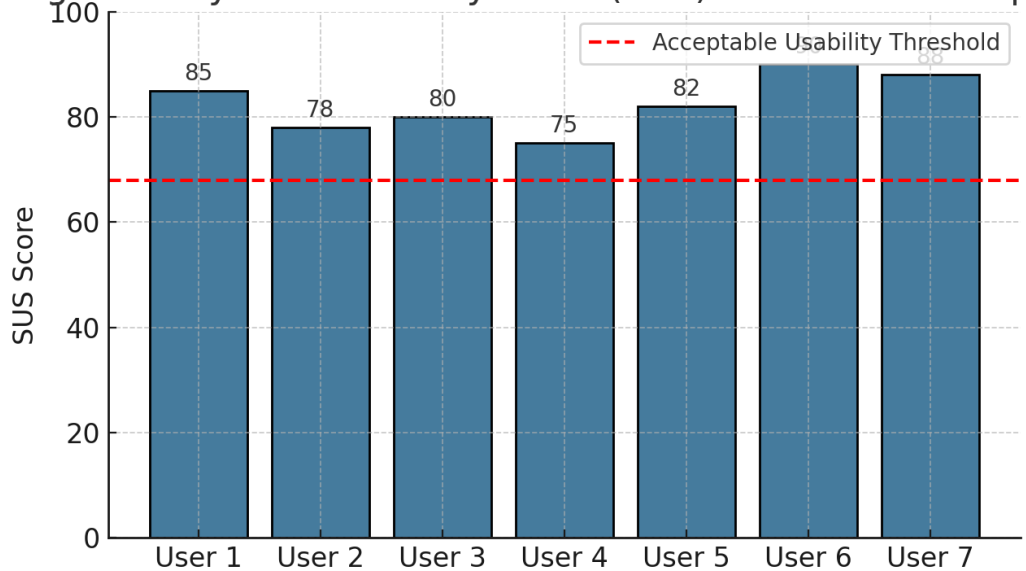


Figure 3. System Usability Scale (SUS) Scores of Participants

This diagram summarizes the protocol’s three phases: collaborative design of simple prompts, individual customization based on cognitive profiles, and participatory evaluation of AI interaction.

Figure 2. Structure of the Three-Phase UDL Protocol

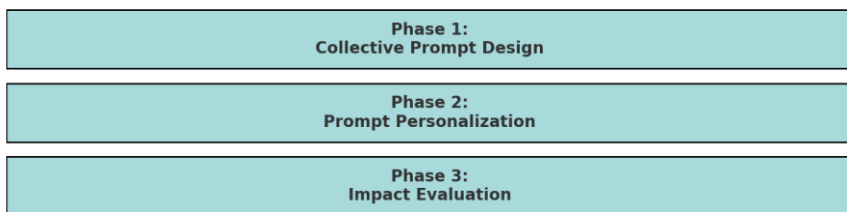


Figure 2. Structure of the Three-Phase UDL Protocol

Facilitators reported a strong sense of ownership among participants, who expressed pride in creating their own questions and editing interview-style texts generated by the AI. Participant feedback following the activities highlighted a generally positive perception of ChatGPT. Notably, six individuals indicated that they viewed the tool as a valuable resource for developing future interview content. One participant commented that it “could be a great help” (“potrebbe

darmi una grande mano”), while another described the experience as “enjoyable” and expressed a desire to deepen their understanding of artificial intelligence: “I would like to learn more about AI” (“è stata una bella esperienza, vorrei saperne di più sull’IA”). These outcomes suggest that a UDL- and ICF-based approach can effectively bridge cognitive barriers and promote meaningful use of AI tools in inclusive educational contexts.

4. Discussion

The findings of this study underscore the significant impact of Universal Design for Learning (UDL) when applied to AI-mediated educational interactions for individuals with intellectual disabilities. The implementation of the UDL-based protocol not only reduced task execution times but also led to qualitatively improved user outputs, as reported by facilitators and corroborated by participant feedback.

The reduction in completion time—from 5:50 minutes without support to 3:29 with the UDL protocol—illustrates the tangible benefits of structured, inclusive prompt design. This efficiency gain aligns with the observed increase in user confidence, engagement, and content relevance, reinforcing the role of personalization and multimodal access strategies in reducing cognitive load.

Moreover, the use of the System Usability Scale (SUS) offered a structured insight into the perceived usability of the AI interface. Participants reported high levels of satisfaction with the clarity and supportiveness of the prompts, particularly under the UDL-driven configuration. These findings confirm that accessibility must go beyond technical affordance to encompass cognitive, linguistic, and relational dimensions.

It is also worth noting that such promising results were achieved within a real-world, socially contextualized setting—namely, a cooperative serving adults with intellectual disabilities. This reinforces the scalability of the approach in community-based or non-formal educational contexts, provided that adequate training and facilitation resources are available.

Future research should explore automated methods for dynamic prompt adaptation and investigate longitudinal effects of inclusive AI usage on self-expression and digital autonomy among neurodivergent populations. Ultimately,

these findings contribute to the growing discourse on ethical, inclusive AI by showcasing a replicable and pedagogically grounded model that prioritizes user dignity and agency.

4.1 Strengths and weaknesses of the protocol tested

The initial implementation of AI chatbot interaction—prior to the adoption of the UDL-based protocol—highlighted several critical limitations. Participants required extended time to complete the assigned tasks and frequently produced outputs that diverged significantly from the intended prompts. These challenges were primarily due to the complexity and lack of structure in the initial queries, which did not account for the participants' cognitive profiles or processing needs.

However, after the application of the structured UDL-informed protocol, a marked improvement was observed. The time required to complete the same tasks was approximately halved, and the responses generated by the participants, with the support of the AI, were considerably more coherent and aligned with the original prompt goals. This suggests that the prompt personalization process and scaffolded interaction design played a critical role in reducing cognitive load and supporting comprehension.

Among the key strengths of the protocol was its emphasis on collective prompt design, the adaptation of language complexity, and the integration of multimodal aids. These factors significantly enhanced participant engagement, motivation, and clarity in task execution. Additionally, the flexibility embedded in the UDL framework allowed for real-time modifications based on observed needs during the interaction, promoting a more inclusive and empowering learning environment.

Nonetheless, some limitations were also identified. The protocol's implementation required trained facilitators capable of mediating between user needs and AI affordances, a condition not always replicable in less supported contexts. Furthermore, the customization process—though effective—was time-consuming in its setup phase, necessitating detailed functional profiling and preparatory materials. Future iterations of the protocol may benefit from streamlined assessment tools and automated adaptation systems to enhance scalability.

Overall, the coherence across the theoretical framework, methodology, and observed outcomes confirms the internal consistency of the study design. The integration of Universal Design for Learning (UDL) with functional profiling via ICF represents a replicable approach for inclusive educational innovation. This work

contributes to advancing empirical evidence on the usability of AI in special education contexts and calls for broader adoption of participatory design principles. Future studies could expand the protocol to other cognitive profiles and learning environments, including formal schooling and vocational training.

5. Conclusions and Future Directions

This study proposed a protocol grounded in Universal Design for Learning (UDL) and the International Classification of Functioning, Disability and Health (ICF) to enhance the accessibility and usability of AI chatbots for young adults with intellectual disabilities. The initial phases of the research focused on co-constructing chatbot prompts with the participants, customizing the interactions based on individualized functional profiles, and testing the educational potential of generative conversational AI within an inclusive pedagogical framework. The dual use of UDL and ICF enabled a personalized and flexible design, ensuring that the technological interface could adapt to diverse cognitive, linguistic, and relational profiles. The UDL principles promoted the creation of multimodal interaction pathways—offering multiple ways of representation, engagement, and expression—while the ICF framework provided a structured methodology to assess individual functioning and environmental barriers, guiding the customization of prompts to optimize accessibility.

This case study adhered to rigorous methodological principles to ensure the credibility and transferability of findings. Triangulation of data sources was employed, including participant observations, AI-generated outputs, and post-session debriefings. Data collection instruments such as field notes and comprehension questionnaires were standardized across sessions and administered by trained facilitators. All participants were engaged in the three-phase protocol implementation over a 4-week period, with consistent session durations and facilitator prompts. Ethical considerations were upheld through informed consent procedures and anonymization of responses. The qualitative design enabled in-depth exploration of individual learning pathways and AI interaction experiences, consistent with best practices in inclusive pedagogical research.

Author contributions

Although the research was conducted by all the authors and this work is the result of their joint effort, the individual paragraphs, however, are attributed as follows: Introduction: Alba Caiazzo, Caterina Sapone; Theoretical Framework: Alba Caiazzo; Methodology: Maria Concetta Carruba; Analysis and results: Maria Concetta Carruba; Discussion: Maria Concetta Carruba, Caterina Sapone; Conclusion: Caterina Sapone, Alba Caiazzo. The abstract, in both English and Italian versions, was collaboratively developed and approved by all authors

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Sitography

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