Nafath

by Mada

Issue no. 30
November 2025

www.mada.org.qa

Learning without Limits

The importance of Assistive Technology and Digital Accessibility

ISSN 0278-9914

Nafath
by Mada

Issue no. 30
November 2025

ISSN (online): 2789-9152
ISSN (print): 2789-9144

About Mada

Mada – Assistive Technology Center Qatar, is a private institution for public benefit, which was founded in 2010 as an initiative that aims at promoting digital inclusion and building a technology-based community that meets the needs of persons with disabilities (PWDs). Mada today is the world's Center of Excellence in digital accessibility in Arabic.

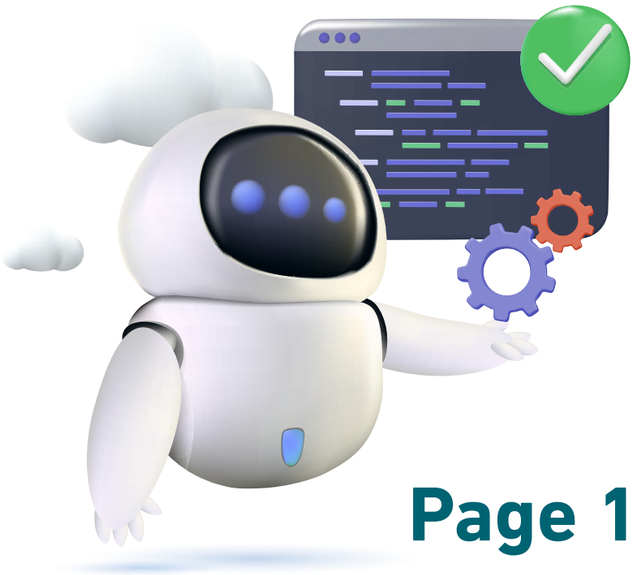
The Center works through smart strategic partnerships to enable the education sector to ensure inclusive education, the community sector through ICTs to become more inclusive, and the employment sector to enhance employment opportunities, professional development and entrepreneurship for persons with disabilities.

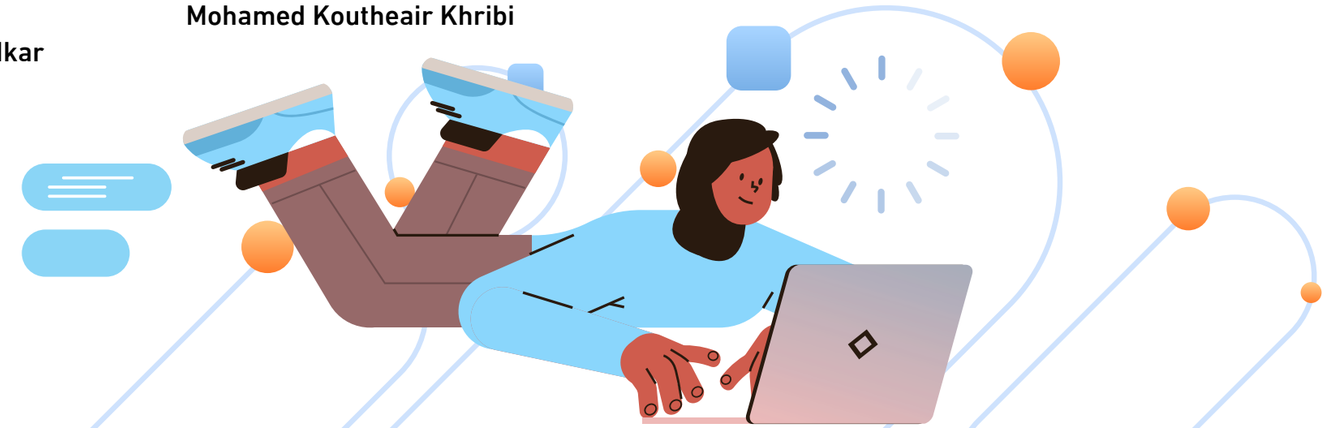
The Center achieves its goals by building partners' capabilities and supporting the development and accreditation of digital platforms in accordance with international standards of digital accessibility. Mada also raises awareness, provides consulting services, and increases the number of assistive technology solutions in Arabic through the Mada Innovation Program to ensure equal opportunities for the participation of persons with disabilities in the digital society.

About Nafath

Nafath aims to be a key information resource for disseminating the facts about latest trends and innovation in the field of ICT Accessibility. It is published in English and Arabic languages on a quarterly basis and intends to be a window of information to the world, highlighting the pioneering work done in our field to meet the growing demands of ICT Accessibility and Assistive Technology products and services in Qatar and the Arab region.

Content Page





Nafath
by Mada

Open call for papers

"Nafath" an open access journal, solicits original research contributions addressing the accessibility, usability, and key information resource for disseminating the facts about latest trends and innovation in the field of ICT Accessibility to enable persons with disability and the elderly. Nafath is focusing on the theoretical, methodological, and empirical research, of both technological nature, that addresses equitable access and activate participation of potentially all citizens in Information Society.

Topics of specific interest

Important aspects and topics to be discussed evolve around (but are not limited to):

- Accessibility guidelines
- Accessible games
- Adaptable and adaptive interfaces
- Alternative and augmented Input /Output techniques
- Applications of assistive technologies in the mainstream
- Architectures, development methods and tools for ICT Accessibility
- Design for All and accessibility education and training
- Evaluation of Accessibility, Usability, and User Experience
- Innovative Assistive applications and environments and ICT Accessibility solutions
- Localization
- Novel designs for the very young, the elderly, and people with different types of disabilities
- Novel interaction techniques, platforms, metaphors, and devices
- Personalization techniques and personalized products and services
- Smart artifacts, smart cities and smart environments
- Web accessibility

In addition to the above, Nafath can host special issues, book reviews and letters to the editor, announcements (e.g. conferences, seminars, presentations, exhibitions, education and curricula, awards, new research programs), and commentaries (e.g. about new policies or legislation).

Why publish with us?

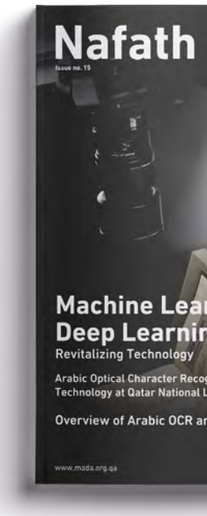
Nafath is registered and indexed by DOI. All issues have an ISSN number for online and print version.

To submit a paper please visit:

https://nafath.mada.org.qa/submit-your-paper/

or send it directly to the editors by email to:

edge@mada.org.qa



ByteBot AI
A Bilingual, Accessible Coding Game for Children

Namrata Alandkar
nalandkar@appnocrat.com

Appnocrat Technology Pvt Ltd
India

Abstract - ByteBot AI is an innovative coding game designed to empower children with physical disabilities by making STEM education fun, engaging, and inclusive. Children with physical disabilities face significant barriers in accessing STEM education, particularly in coding, due to the limited accessibility features in existing educational games. This creates a research and practice gap in inclusive digital learning tools tailored to their needs. ByteBot AI was developed as a bilingual (Arabic–English) coding game designed specifically for children with severe physical disabilities, supporting adaptive inputs such as eye tracking, switches, and head tracking. The solution combines gamification with structured learning modules to introduce coding concepts like sequences, loops, and arrays. Preliminary user testing with participants (ages 6–14) and the internal team revealed high engagement (92% completion of Level 1 tasks), improved independence in gameplay, and positive feedback from participants who observed gains in problem-solving and confidence. This paper presents the design process, user experience considerations, and localisation strategies adopted. The findings contribute to the field of accessible ICT and inclusive education by offering a scalable model for culturally and linguistically adapted assistive learning games.

Keywords
Accessible coding education; Assistive Technology; Inclusive STEM education; Gamified learning.

1 Introduction

In an increasingly digital world, coding has become a vital skill that empowers children to think critically, solve problems, and build future-ready careers. Across the globe, gamified learning platforms are helping young learners engage with coding concepts in fun and interactive ways. However, for many children with physical disabilities, these opportunities are often inaccessible. Standard educational games rarely include adaptive technologies, leaving children who rely on eye tracking, switches, or alternative input methods excluded from valuable STEM learning experiences [1].

Globally, digital skills are increasingly recognised as essential for future education and employment opportunities [2]. Inclusive Information and Communication Technologies (ICTs) play a vital role in bridging these educational gaps, especially for children with motor impairments who are often left out of standard coding games due to their reliance on conventional input methods like keyboards or touch screens. Furthermore, most platforms fail to account for cultural and linguistic differences, limiting access even further.

ByteBot AI addresses this research gap by providing an inclusive, bilingual coding platform for children with physical disabilities aged 6–14. The game combines adaptive accessibility features - such as eye tracking, switch scanning, and head tracking - with a user-friendly, gamified design that introduces essential coding principles, including sequences, loops, and conditional statements. Its structured modules ensure that concepts are built progressively, allowing learners to develop confidence and mastery at their own pace.

2 Methodology

The development of ByteBot AI followed a co-design methodology to ensure that the final product was not only technically robust but also genuinely responsive to the needs of its intended users. The process unfolded across three milestones: co-design and scoping, design sprints and iteration, and comprehensive testing.

2.1. Co-design and Scoping

A series of testing rounds was conducted with participants. These sessions helped define both the educational requirements and the accessibility features most needed in the game. Key feedback emphasised the importance of customizable visual supports, simplified navigation pathways, and the inclusion of multiple adaptive input options (e.g., switches, eye tracking, and head tracking).

One challenge highlighted during this phase was balancing game complexity with accessibility - ensuring that learning tasks remained engaging without overwhelming users with cognitive or motor demands.

2.2. Design Sprints and Iteration

Using rapid prototyping, the team developed interactive mock-ups and assessed them internally and with participants in short cycles. Feedback was integrated after each round, ensuring continuous refinement. For example, early beta testing revealed difficulties with small interactive targets, particularly for children using eye-tracking systems. In response, larger interactive icons and clearer visual cues were introduced. Participants also suggested step-by-step tutorials to reduce initial learning barriers, which were incorporated into later prototypes. These iteration cycles ensured that the game's design aligned with both accessibility standards and classroom usability.

2.3. Quality Assurance and Finalization

Comprehensive testing was carried out to evaluate both functionality and accessibility.

- **Participants**
  Six children took part in the testing, helping ensure the design met real user needs.
- **Data Collection**
  Data was gathered through observations, participant feedback, and iterative testing sessions. This helped identify accessibility issues, navigation problems, and how well tutorials worked.
- **Data Analysis**
  Four rounds of testing and feedback were conducted. Feedback was reviewed and used to improve the design. Patterns in the responses guided changes, ensuring the platform was easy to use, accessible, and supported learning goals.

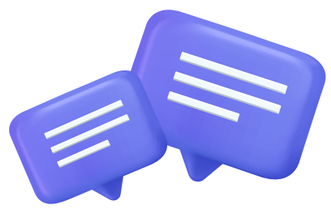
3 Accessibility and User Experience

ByteBot AI was built to support diverse accessibility needs through multiple adaptive input methods, including:

- Eye tracking
- Switch scanning
- Head tracking
- Screen taps

The game modules are structured into three main levels with nine sub-levels, each progressively introducing coding concepts such as sequencing, loops, and conditional statements. Gamification elements, visual cues, and interactive challenges make learning fun and rewarding, while a customisable settings page allows children to adjust language, audio, and visuals to suit their preferences. This ensures that children with varying abilities can learn coding concepts in an environment that is both supportive and motivating.

To evaluate usability, testing was conducted internally. Observations demonstrated how adaptive inputs enhanced accessibility and independence.



Input	Benefit	Output
Eye Tracking	Enables play without hand movement	successfully completed coding sequences
Switch access	Allows single-tap navigation	successfully completed coding sequences
Head tracking	Facilitates hands-free coding play	successfully completed coding sequences
Screen tap	Supports traditional touch navigation	successfully completed coding sequences

Table 1. Accessibility Inputs and Outcomes

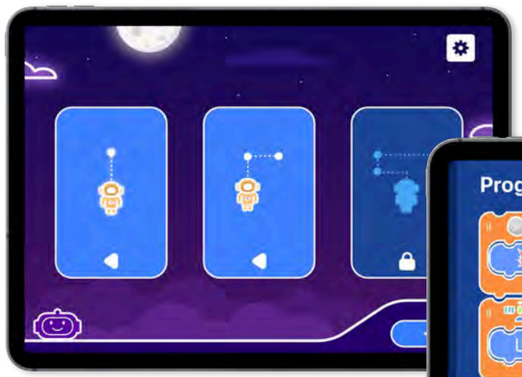


Figure 1. Activity/ Games Selection Screen

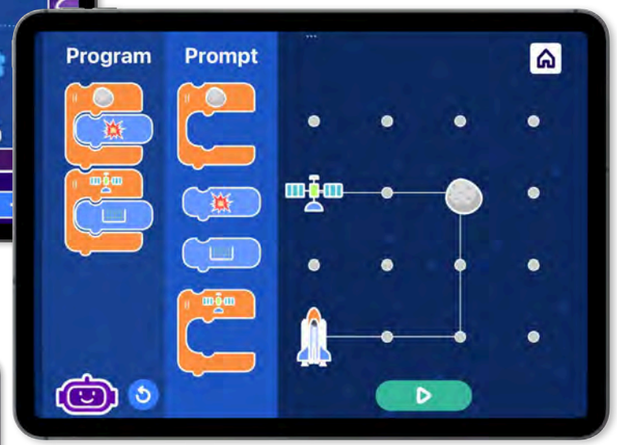


Figure 2. Gameplay screen showing the "if" conditional statement

Figure 3. Arabic Game Screen with Scanning Feature

Figure 4. Settings screen

4

Localizing Text

A key innovation of ByteBot AI lies in its **cultural and linguistic adaptation**. Unlike most coding platforms that primarily use English, ByteBot AI is available in both **Arabic and English**, making it accessible to learners across the Gulf region.

Several concrete adaptations were implemented to ensure the platform feels familiar and engaging for Arabic-speaking children:

- **Right-to-left text orientation** was applied throughout the Arabic interface to align with native reading patterns.
- **Language-sensitive instructions** were developed, avoiding direct translations of English phrases and instead using age-appropriate Arabic expressions that resonate with young learners.
- **Bilingual audio prompts** allow children to hear instructions in their chosen language, supporting both independent play and classroom use.

These adaptations not only break down language barriers but also create a sense of belonging and inclusivity, which is essential for sustained engagement. Research highlights the importance of mother-tongue education in enhancing comprehension and accessibility for learners with disabilities [3]. By embedding these principles, ByteBot AI ensures that children can engage with coding concepts in a way that feels culturally relevant and linguistically accessible.

Figure 5. Settings screen 1 in Arabic

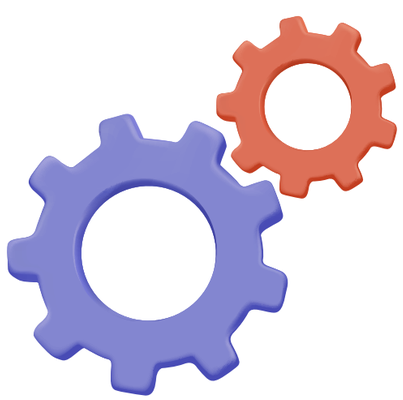
Figure 6. Settings screen 2 in Arabic

5 Opportunities for Future Development

The launch of ByteBot AI marks an important milestone, but the journey of innovation continues. Future opportunities include:

- Expanding coding levels to introduce more advanced concepts.
- Adding gamified features such as leaderboards and achievement badges.
- Extending platform compatibility to Android and desktop devices.
- Introducing multilingual support to reach wider communities in the region.

By continuing to grow, ByteBot AI can reach more learners, strengthen STEM education, and inspire innovation in accessibility solutions.



6 Conclusion

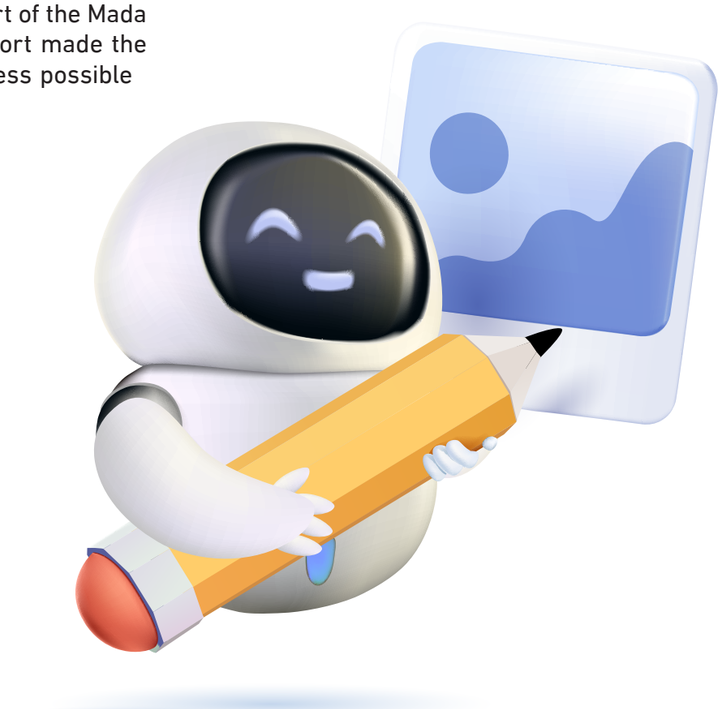
ByteBot AI represents a significant advancement in accessible ICT and inclusive education, providing children with physical disabilities the opportunity to learn essential coding skills in a supportive, engaging, and culturally relevant environment. By integrating adaptive input methods such as eye tracking, switch scanning, head tracking, and screen taps, the platform ensures accessibility for learners with diverse physical abilities.

Beyond accessibility, ByteBot AI's bilingual design and localized content demonstrate the importance of cultural and linguistic inclusivity, enabling children in the Gulf region to engage with STEM education in their native language. Observational studies and pilot testing indicate that the platform enhances independence, engagement, and confidence, while structured gamification fosters sustained motivation to learn coding concepts progressively.

In summary, ByteBot AI not only contributes to the broader field of assistive ICT but also has the potential to make a tangible positive impact on the educational and personal development of children with disabilities in the region. By providing an inclusive, interactive, and empowering platform, ByteBot AI paves the way for future innovations that support both accessibility and STEM learning, inspiring the next generation of digitally literate and confident learners.

Acknowledgment

This project was developed as part of the Mada Innovation Program, whose support made the co-design and development process possible



References

1. T. Levinson, L. Hunt, and Z. R. Hassenfeld, 'Including Students With Disabilities in the Coding Classroom', Teach. Comput. Think. Coding Young Child., 2021, doi: 10.4018/978-1-7998-7308-2.ch012.
2. A. Weber and S. Greiff, 'ICT Skills in the Deployment of 21st Century Skills: A (Cognitive) Developmental Perspective through Early Childhood', Appl. Sci., 2023, doi: 10.3390/app13074615.
3. F. Walizadah, 'The Role of Mother Tongue in Education', J. Learn. Dev. Stud., vol. 5, no. 1, pp. 40–48, Apr. 2025, doi: 10.32996/jlds.2025.5.1.5.

AI-Powered Chatbots for Fostering Inclusive Digital Education

Opportunities and Challenges

Maria Aidarus
mariaaidarus252@gmail.com
Carnegie Mellon University in Qatar

Urooj Shah
uroojshah5826@gmail.com
UDST – Qatar

Mohamed Koutheair Khribi
mkhribi@mada.org.qa
Mada Center

Keywords
Inclusive Education; Accessibility; Generative AI; Conversational Chatbots; Digital Learning; Assistive Technology

Abstract- This paper explores the potential of AI-powered chatbots as transformative tools for advancing inclusive digital education (IDE). Designed to simulate human dialogue and deliver personalized guidance, chatbots provide multimodal access, multilingual support, and continuous assistance. These features make them especially valuable for learners with disabilities (PWDs), who often require alternative pathways to information and adaptive feedback aligned with inclusive design principles. After reviewing different chatbot types, we highlight their educational benefits, such as real-time tutoring, workload reduction for educators, and tailored learner pathways. A snapshot of related work demonstrates early use cases in both mainstream and inclusive education contexts, while also pointing to gaps in research on accessibility for PWDs. A comparative review of existing platforms shows that enterprise-grade solutions excel in governance and accessibility, while generative models offer adaptability but raise concerns of accuracy and explainability. The discussion emphasizes that while AI chatbots hold great promise, challenges remain around bias, inclusivity, privacy, and over-reliance. Future research should investigate sustainable deployment models, safeguards, and integration strategies to ensure that AI chatbots advance inclusive, equitable, and learner-centered education.

1. Introduction

Accessible digital learning lies at the heart of inclusive education, ensuring that persons with disabilities (PWDs) can participate fully and equitably. In today's digitized educational landscape, meaningful engagement requires innovations that move beyond traditional assistive technologies. Artificial Intelligence (AI), particularly conversational AI, is emerging as a transformative force. Among its most promising tools are AI-powered chatbots, which provide real-time feedback, adaptive content delivery, and multimodal interaction. These systems create opportunities for personalization, multilingual access, and continuous support. These are also features that are particularly valuable for learners with disabilities who need alternative pathways to information and learning content [1, 2].

Despite the progress of inclusive digital education, challenges remain. Existing systems often lack adaptive feedback loops, multilingual accessibility, or integration with assistive technologies. AI chatbots offer a way to bridge these gaps, aligning with broader goals of equity and universal design in education.

This paper explores their potential in advancing inclusive digital education. It reviews chatbot concepts and types, synthesizes findings from related work, highlights accessibility and pedagogical benefits, examines challenges and safeguards, summarizes comparative evaluations, and concludes with implications for future adoption.

2. AI Chatbots

Concepts & Types

Conversational AI refers to systems that simulate human dialogue through natural language interfaces, such as text or voice. AI-powered chatbots are a subset of these systems, designed to autonomously respond to user queries and provide guidance [3].

Chatbots can mainly be categorized into the following types:

- **Rule-based chatbots:** Follow predefined scripts; reliable for structured tasks but lack flexibility and adaptability to unexpected queries [4].
- **Retrieval-based chatbots:** Select responses from a predefined set; balance control and adaptability [3].
- **Generative chatbots:** Use large language models (LLMs) to generate original responses; enable rich dialogue but risk inconsistency [4].
- **Hybrid chatbots:** Combine structured and generative methods to balance reliability and adaptability [5].

From an inclusivity perspective, generative and hybrid chatbot models can enhance adaptive learning by personalizing educational content and providing tailored feedback based on individual learner needs and abilities. Furthermore, voice-first conversational systems and embodied agents (e.g., AI-driven avatars and/or robots) enable multimodal interaction channels, offering alternative and accessible modes of engagement for learners with diverse disabilities [6].

3. Related Work Snapshot

Several studies highlight the role of chatbots in education. Khan Academy's chatbot Khanmigo serves as an AI tutor aligned with mastery-based curricula, offering accessibility features such as voice interaction [7]. Georgia Tech's Jill Watson reduces instructor workload by providing timely, automated assistance in online courses [8]. Mraihi et al. [2] demonstrated how a multilingual, speech-enabled chatbot in MOOCs improved engagement and inclusivity for learners with disabilities.

More recently, researchers have begun to explore chatbots explicitly designed for accessibility and inclusivity. Mateos-Sanchez et al. [9] developed CapacitaBOT, a mobile chatbot that supports individuals with intellectual disabilities in training social skills during COVID-19 lockdowns. Their study showed how conversational agents can serve as inclusive educational tools, fostering participation and reducing isolation for vulnerable learners. Similarly, Wang et al. [10] conducted a systematic review of generative AI in special education, synthesizing evidence from 33 studies. Their findings highlighted significant opportunities for personalization and accessibility, while also cautioning that risks such as bias, ethical concerns, and inconsistent accuracy must be carefully managed in inclusive learning contexts.

Taken together, these studies illustrate both the promise and limitations of AI-powered chatbots in inclusive digital education. While tools like Khanmigo and Jill Watson demonstrate the scalability of conversational AI in mainstream learning, there remains a notable research gap in addressing the needs of PWDs, especially in multilingual and resource-constrained environments.

4. Potential for Inclusive Digital Education

4.1 Accessibility Benefits

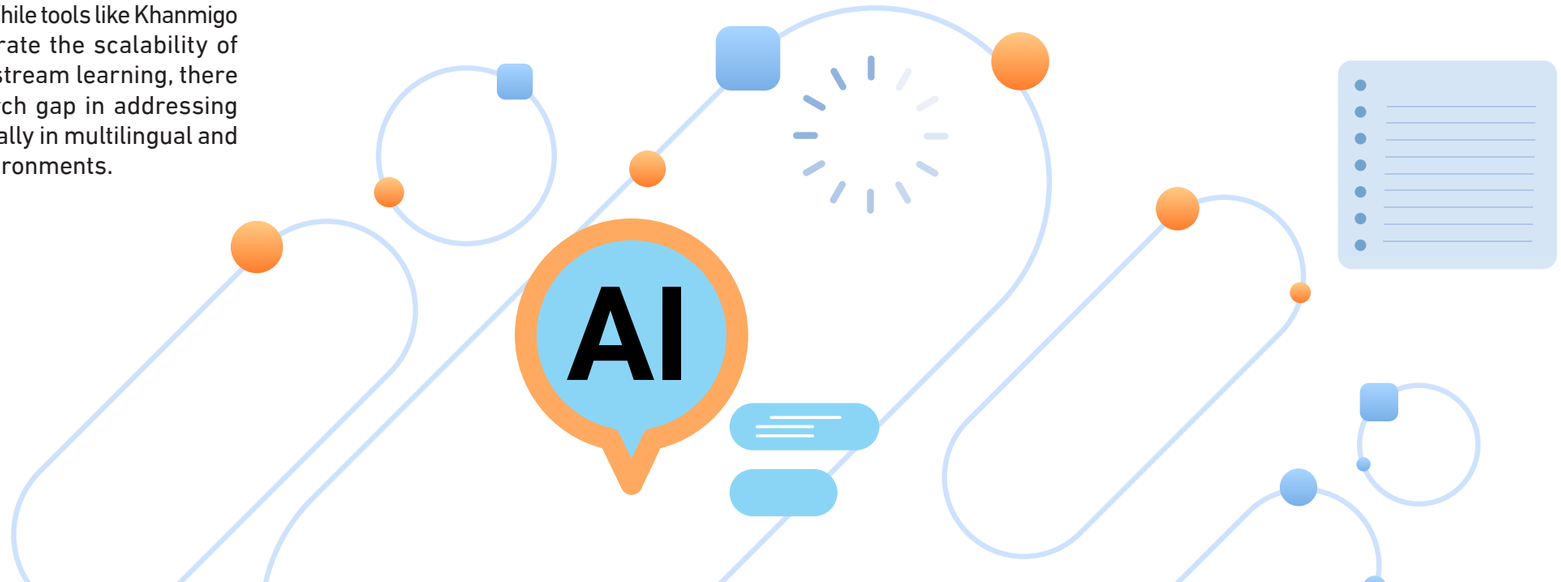
AI-powered chatbots advance accessibility by supporting multimodal interaction including speech-to-text, text-to-speech, voice-based dialogue, and screen reader compatibility [1, 2]. These features are particularly beneficial for learners with visual, hearing, or motor impairments, providing alternative ways to access and interact with educational content.

Furthermore, many modern chatbot frameworks now incorporate multilingual support and accommodate right-to-left (RTL) scripts [9], which is essential for inclusive learning environments, particularly in bilingual and multilingual educational contexts.

Another key accessibility benefit lies in adaptive feedback mechanisms, where AI powered chatbots personalize responses based on individual learners' cognitive profiles, learning preferences, or specific functional needs. By dynamically tailoring instructions, examples, and explanations, chatbots reduce participation barriers and promote equitable learning opportunities for diverse learners.

4.2 Educational Benefits

Beyond accessibility, AI-powered chatbots have the potential to improve teaching and learning by acting as virtual tutors that support students even outside the classroom. They can answer common academic questions, give explanations when needed, and provide adaptive resources. This helps reduce teachers' workload and allows them to focus more on personalized support for students [10]. In massive open online courses (MOOCs), where interaction between instructors and students is often limited, chatbots can offer scalable and consistent guidance to many learners at once. Tools like Quizlet's Q-Chat and Coursera Coach are designed to personalize study tips based on each learner's progress and performance. These tools can help students become more independent, improve retention, and even reduce learning-related anxiety [11]. In addition, embodied conversational agents and voice-first assistants — such as AI-powered avatars, humanoids, or smart speakers — have shown strong potential to increase student engagement and motivation. These tools are especially helpful for younger learners and neurodiverse students [6]. By offering interactive, multimodal learning experiences, they encourage students to participate actively and provide inclusive pathways to build critical thinking and problem-solving skills.



5. Comparative Review Summary

A comparative review of leading chatbot platforms, conducted in the context of our broader research, revealed key trade-offs in their suitability for supporting inclusive digital education. Enterprise-grade platforms such as IBM Watson Assistant and Microsoft Copilot Studio demonstrated strong performance in accessibility which ensures WCAG 2.1 compliance, assistive technology support, and inclusive design [2, 6]. They also excel in governance, providing privacy, transparency, and bias monitoring mechanisms critical for trustworthy adoption in education [12]. Their seamless integration capabilities—spanning WordPress, LMSs, Teams, and SharePoint—make them highly reliable for institutional deployment where compliance, scalability, and long-term sustainability are essential [3].

By contrast, generative platforms such as ChatGPT and Claude excel in adaptability, rich dialogue, and context-aware interactions, offering learners more natural and flexible engagement [4,11]. However, they face challenges with factual accuracy, hallucination risks, and limited explainability, which can undermine their reliability in high-stakes educational settings.

Open-source platforms such as Rasa and Botpress provide maximum flexibility and customizability, empowering developers to tailor solutions to specific pedagogical or linguistic needs [4,9]. Yet, they demand significant technical expertise, higher setup effort, and ongoing maintenance, which may limit adoption in resource-constrained educational contexts [10].

Overall, the most promising path for inclusive digital education appears to be hybrid architectures that combine the strengths of both worlds: the compliance, governance, and integration maturity of enterprise-grade platforms with the adaptability and conversational richness of generative AI [5]. Such hybrid approaches enable institutions to deliver explainable, safe, and accessible chatbot interactions while preserving the flexibility to innovate and personalize learning experiences for diverse learners [1, 2].

6. Challenges & Safeguards

Despite their promise, AI chatbots present challenges. Generative models may hallucinate, producing inaccurate or misleading responses [11]. Over-reliance on automation can reduce critical thinking and meaningful human interaction in education. Accessibility gaps persist when chatbots trained on general datasets fail to meet the needs of learners with disabilities, underscoring the importance of co-design with PWDs and compliance with accessibility standards [2]. Ethical issues around privacy, bias, and informed consent also require attention, particularly in voice-first systems [6]. Safeguards such as explainable AI (XAI), human-in-the-loop oversight, bias monitoring, and inclusive evaluation frameworks are essential [12]. Equally important is training educators to integrate chatbots responsibly, ensuring they complement rather than replace human support.

7. Conclusion

AI-powered chatbots hold transformative potential for inclusive digital education. By enabling multimodal access, adaptive guidance, and multilingual support, they address key accessibility and pedagogical gaps. Comparative evaluations show that while generative models are powerful for adaptability, enterprise-grade platforms provide the governance and inclusivity necessary for sustainable deployment.

Future research should explore hybrid approaches that balance adaptability and accountability, investigate their use in inclusive education contexts, and evaluate long-term adoption strategies. Institutions committed to accessibility—such as Mada and similar organizations—are well positioned to lead the integration of AI chatbots into learning and training platforms, setting benchmarks for inclusive digital education.

References

1. Gibson, R. (2024). The impact of AI in advancing accessibility for learners with disabilities. EDUCAUSE Review.
2. Mraihi, S, Khribi, M. K., and Jemni, M. (2025). " A Generative AI-Powered Chatbot for Enhancing Accessibility and Personalized Learning in MOOCs". 2025 International Conference on Advanced Learning Technologies (ICALT), 2025.
3. Wollny, S., Schneider, J., & Tschimmel, K. (2021). Exploring the use of chatbots in higher education: A scoping review. International Journal of Educational Technology in Higher Education, 18(1), 1–24. https://doi.org/10.1186/s41239-021-00262-0
4. Ali, M., Khan, S., & Hussain, A. (2023). Rule-based, retrieval-based, and generative chatbots: A comparative study. Journal of Intelligent Systems, 32(5), 745–758. https://doi.org/10.1515/jisys-2023-0045
5. Horvat, E., Petrovic, J., & Markovic, S. (2025). Hybrid chatbot architectures for education: Balancing reliability and flexibility. Expert Systems with Applications, 247, 123456. https://doi.org/10.1016/j.eswa.2025.123456
6. Ermolina, N., & Tiberius, V. (2021). Voice assistants in education and accessibility: A systematic review. Education and Information Technologies, 26(6), 7563–7589. https://doi.org/10.1007/s10639-021-10677-9
7. Khan Academy. (2024). Khanmigo: AI tutor and teaching assistant. Khan Academy Blog. https://blog.khanacademy.org/khanmigo
8. Filipsson, J. (2025). AI teaching assistants in online education: Lessons from Georgia Tech's Jill Watson. Journal of Online Learning Research, 11(2), 85–101.
9. Mateos-Sanchez, M., Casado Melo, A., Sánchez Blanco, L., & Fermoso García, A. M. (2022). Chatbot as educational and inclusive tool for people with intellectual disabilities. Sustainability, 14(3), 1520. https://doi.org/10.3390/su14031520
10. Wang, M., Tlili, A., Khribi, M. K., Lo, C. K., & Huang, R. (2025). Generative artificial intelligence in special education: A systematic review through the lens of the mediated-action model. Information Development. Advance online publication. https://doi.org/10.1177/02666669251335655
11. Brünner, P., & Ebner, M. (2025). Conversational AI in MOOCs: Supporting learners through retrieval-augmented chatbots. International Journal of Emerging Technologies in Learning, 20(4), 112–126. https://doi.org/10.3991/ijet.v20i04.45678
12. Stryker, C., & Kavlakoglu, E. (2024, August 9). Artificial Intelligence. IBM.com. https://www.ibm.com/think/topics/artificial-intelligence

Bridging the Gap Between Autism Research and Community Needs

A Participatory Framework for Culturally Responsive Research

Achraf Othman
aothman@mada.org.qa
Mada- Qatar Assistive Technology Center

Sabika Shaban
sshaban@hbku.edu.qa
Hamad Bin Khalifa University

Abstract- At the heart of AutismTech 2025 in Doha, two expert-led panel discussions brought to light the ongoing disconnect between autism research and the everyday realities of autistic individuals, especially within Arabic-speaking communities where cultural and linguistic nuances are often overlooked. Although scientific understanding of autism has advanced globally, much of this progress has yet to translate into meaningful change for families and individuals in the Arab region. The sessions gathered a diverse group of voices—self-advocates, caregivers, clinicians, researchers, and policy leaders—who shared a common concern: research priorities often fail to reflect the lived experiences and needs of the communities they aim to serve. Through a detailed thematic analysis of the discussions, four recurring challenges became evident: a misalignment between research agendas and real-life needs, the absence of culturally adapted tools and communication methods, limited community involvement in the research process, and inadequate channels for sharing findings in accessible ways. In response to these challenges, participants collaboratively shaped a four-pillar participatory framework designed to realign autism research with community-defined goals. The framework calls for inclusive co-design practices, cultural contextualization, accessible dissemination of research outcomes, and stronger accountability mechanisms to ensure that knowledge reaches—and resonates with—those it is meant to benefit. This approach offers a new direction for autism research in the Arab region, moving from top-down methodologies to community-rooted partnerships. By centering lived experience, honoring cultural identity, and committing to shared accountability, the proposed framework has the potential to transform how research is conducted and applied—not just in Qatar, but across similar underrepresented settings.

Keywords- Autism spectrum disorder, Community engagement, Participatory research, Cultural adaptation, Co-design, Arabic context, Neurodiversity, Assistive technology, Research priorities, Stakeholder involvement.

1. Introduction

Autism spectrum disorder (ASD) affects approximately 1 in 100 individuals globally, with increasing recognition of the importance of inclusive, community-centered approaches to research and innovation [1]. However, despite notable advances in neuroscience, genetics, artificial intelligence, and behavioral sciences, a persistent gap remains between academic research outcomes and the lived experiences of autistic individuals and their families [2].

This gap is particularly pronounced in underrepresented cultural and linguistic contexts, where Western-developed interventions and assessment tools may lack cultural validity and appropriateness [3], [4]. In the Arab region, recent research has highlighted significant disparities in autism research representation and the urgent need for culturally adapted approaches [5], [6].

The emergence of participatory research methodologies in autism studies has shown promise in addressing these disparities. Hijab et al. (2024) demonstrated in their systematic review that co-design approaches involving autistic children can provide substantial benefits over traditional design methodologies, particularly when adaptive techniques accommodate diverse communication abilities and cultural contexts [7]. Similarly, several studies have emphasized the importance of accessibility-first approaches in developing inclusive technologies for individuals with disabilities [8], [9].

The AutismTech 2025 conference, held in Doha, Qatar, provided a unique opportunity to explore these challenges within the Arab context. As a rapidly growing technological hub with increasing awareness of autism and disability rights, Qatar represents an important case study for understanding how emerging economies can develop culturally responsive autism research ecosystems [10].

2. Literature Review

2.1. Participatory Research in Autism

The shift toward participatory research in autism has gained momentum over the past decade, driven by advocacy from the autistic community and recognition of the limitations of traditional research approaches [11]. Pellicano et al. (2014) identified significant misalignment between researcher and community priorities, with academic research often focusing on causal mechanisms while communities prioritized practical interventions for daily living [2].

Recent work by Pickard et al. (2022) found that while researchers increasingly recognize the value of participatory approaches, implementation remains challenging due to institutional barriers and methodological uncertainties [12]. Den Houting et al. (2021) emphasized that meaningful participation requires more than consultation demands shared power in research design, implementation, and dissemination [13].

2.2. Co-design and Technology Development

Co-design methodologies have shown particular promise in autism technology development. Hijab et al. (2024) conducted a comprehensive systematic review of co-design processes involving autistic children, identifying 82 studies that demonstrated the benefits of inclusive design approaches [7]. Their analysis revealed four key themes: advances in co-design objectives, participant recruitment strategies, core methodological approaches, and challenge management techniques.

Building on this foundation, Hijab et al. (2025) demonstrated practical implementation of co-design principles in developing collaborative play technologies for autistic children in Qatar [14]. Their work involved nine autistic and four non-autistic children and revealed important insights into social interaction preferences and the potential for technology to facilitate inclusive play experiences.

2.3. Cultural Adaptation and Arab Context

The importance of cultural adaptation in autism research has been increasingly recognized, particularly in non-Western contexts. Al Maskari et al. (2018) conducted a systematic review of cultural adaptations of autism screening tools in non-English speaking countries, finding significant variations in adaptation approaches and validation outcomes [15].

In the Arab region specifically, recent research has begun to address historical gaps in autism research representation. Bahameish et al. (2025) examined autistic traits and internet use patterns in Qatar, providing rare empirical data on autism experiences in the Middle East [5]. Their work highlighted the need for culturally validated assessment tools and region-specific research priorities.

Al-Thani et al. (2021) explored stakeholder perspectives on assistive technology adoption among older adults in Qatar, revealing important insights about cultural barriers to technology acceptance that may extend to autism contexts [3]. Their stakeholder engagement methodology provides a model for inclusive research approaches in the region.

2.4. Research Gaps and Opportunities

Despite these advances, significant gaps remain in our understanding of how to effectively bridge research-community divides in autism, particularly in non-Western contexts. Current literature lacks comprehensive frameworks for implementing participatory research at scale, and few studies have examined the specific challenges and opportunities present in the Arab region.

The present study addresses these gaps by synthesizing expert perspectives from a diverse stakeholder panel and developing a practical framework for culturally responsive autism research that can inform both regional and global practice.

3. Methods

3.1. Study Design

This study employed a qualitative approach using expert panel methodology to synthesize stakeholder perspectives on autism research-community gaps. The research was conducted as part of the AutismTech 2025 conference held in Doha, Qatar, from April 15-17, 2025.

3.2. Panel Structure and Participants

Two complementary panel discussions were organized to explore different aspects of the research-community gap:

Panel	Focus	Participants	Moderator
Panel 1	Community Voices and Research Priorities	3 panelists + 1 moderator	Sabika Shaban (QADR[1]/ HBKU[2])
Panel 2	Research Expectations and Responsibilities	3 panelists + 1 moderator	Dr. Achraf Othman (Mada[3] Qatar)

[1]Qatar Disability Resource (QADR)
[2]Hamad Bin Khalifa University (HBKU)
[3]MADA: Qatar Assistive Technology Center

3.3. Participant Perspectives

The study involved eight key stakeholders representing diverse perspectives within the autism community, including holding multiple roles:

Stakeholder Category	Participants	Roles
Community Representatives	4	Self-advocate, parents
Education/ Clinical Experts	2	Special educator, Consultant psychiatrist
Technology Specialists	3	Technology developers
Academicians	4	University professionals, researchers

3.4. Data Collection

Panel discussions were conducted in English with simultaneous Arabic interpretation available. Each panel session lasted 40 minutes and followed a semi-structured format with predetermined themes while allowing for organic dialogue development. Detailed notes were taken by moderators.

3.5. Data Analysis

We employed thematic analysis following Braun and Clarke's (2006) six-phase approach: (1) familiarization with data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing the report [16]. Two researchers independently coded the data, with disagreements resolved through discussion and consultation with a third researcher.

4. Results

4.1. Panel 1
Community Voices and Research Priorities

Panel 1 discussions revealed critical community concerns around the practical relevance of current research. The self-advocate participant (Mursi Seraj) emphasized the importance of research that directly addresses daily living challenges: "We need research that helps us navigate the real world, not just understand our brains."

Parent participant Hayat Zakaria drew attention to the cultural and linguistic disconnect in existing autism interventions, particularly for adults over the age of 25. She emphasized that many of the available tools were designed with Western assumptions and fail to address the realities of lifelong care in Arab families. She shared her personal experiences on the disparities that exist between existing tools and services and her family's cultural identity and language, and the challenges for adults with autism like her sons to be able to access technological support to improve their quality of living.

The learning support teacher (Ranjana Ranganathan) stressed the importance of practical, implementable solutions in educational settings: "Research findings often give us insight into doable possibilities of successful outcomes for the child. If we could develop such action into consistent practice, involving all stakeholders, both at home and in school, as well as document their practical implementation, then they could serve as a reliable system to advance inclusion."

4.2. Panel 2
Research Expectations and Responsibilities

Panel 2 discussions focused on researcher perspectives and institutional responsibilities. Dr. David Brown acknowledged historical oversights in community engagement: "We've been studying autism for decades, but too often without meaningfully involving autistic individuals in setting research priorities."

Dr. John-John Cabibihan emphasized the need for interdisciplinary collaboration: "Technology solutions need to be developed in partnership with communities, not imposed upon them. This requires fundamental changes in how we approach research design."

Dr. Asma Amin underscored the challenges of translating clinical research into practical outcomes, emphasizing the pressing need to bridge the gap between scientific findings and the quality of services available to autistic individuals. “We have a responsibility to ensure that research findings translate into improved services and support systems,” she stated. “This requires ongoing dialogue between researchers and service providers.” She also warned of a growing concern: the impact of technology addiction among children and youth, which not only complicates early screening and diagnosis but also interferes with the effectiveness of therapeutic interventions. Without addressing this digital dependency, she argued, both assessment and care risk becoming increasingly misaligned with the real needs of the autistic community.

4.3. Emergent Themes

Thematic analysis revealed four major themes that cut across both panels:

Theme 1
Practical Relevance Gap

Participants consistently identified a disconnect between research priorities and daily living needs. Research often focuses on theoretical understanding while communities need practical interventions for education, healthcare, employment, and independent living.

Theme 2:
Cultural and Linguistic Barriers

Arabic-speaking participants highlighted the inadequacy of Western-developed tools and interventions. Cultural norms, family structures, and linguistic differences create significant barriers to implementing existing research findings.

Theme 3:
Authentic Community Engagement

Both panels emphasized the need for genuine partnership rather than tokenistic consultation. Community members should be involved as equal partners throughout all research phases, from planning to dissemination.

Theme 4:
Accountability and Accessibility

Participants stressed the need for research outcomes to be communicated in accessible formats and for researchers to be accountable for real-world impact. This includes ongoing feedback mechanisms and adaptation based on community input.

5. Discussion

5.1 Alignment with Existing Literature

Our findings align closely with international literature on participatory autism research. The practical relevance gap identified by our participants mirrors findings from Pellicano et al. (2014) and Roche et al. (2021), who documented similar misalignments between research and community priorities in Western contexts [2], [11].

The emphasis on cultural adaptation resonates with recent work by Al-Thani and colleagues, who have consistently highlighted the importance of culturally responsive approaches in technology and disability research [3], [5]. Hijab et al. (2024)'s systematic work on co-design methodologies provides a methodological foundation for implementing the participatory approaches called for by our panel participants [7].

5.2 Regional Context and Implications

The Arab region faces unique challenges in autism research and service provision. Historical underrepresentation in international research, combined with rapid social and technological change, creates both obstacles and opportunities for developing innovative approaches [6].

Qatar's emergence as a research hub, exemplified by institutions like Mada Qatar Assistive Technology Center and the growing research portfolio at institutions like HBKU, provides a model for how regional capacity can be developed while maintaining cultural authenticity [8].

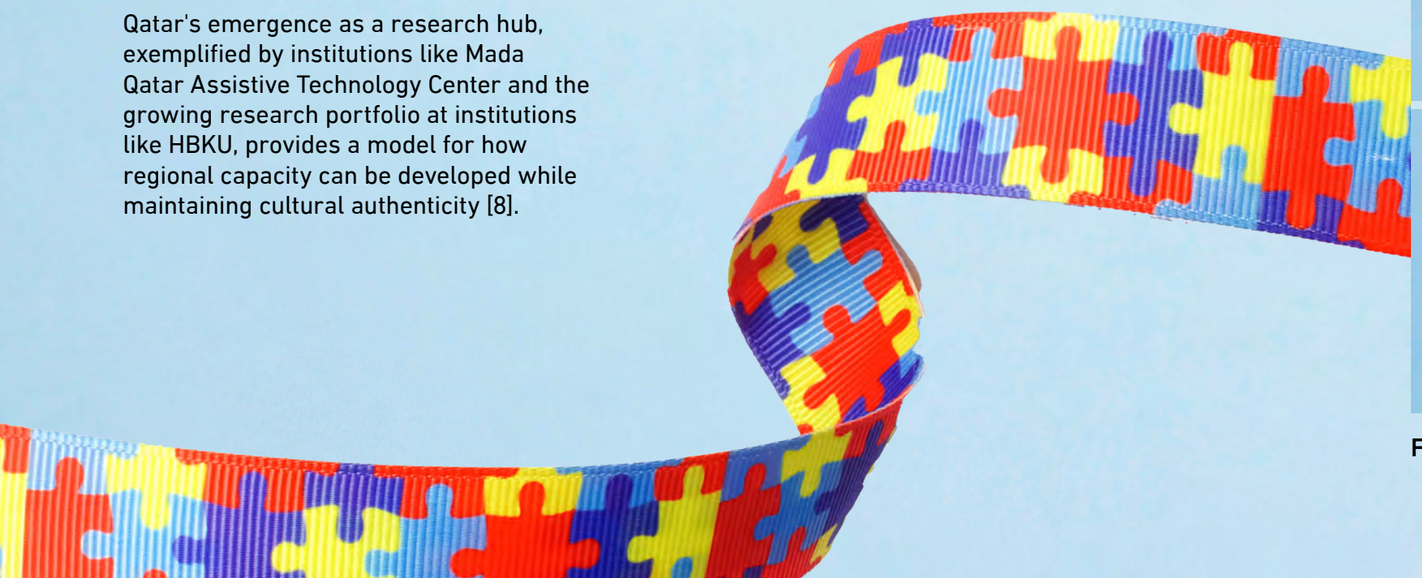
5.3 Methodological Contributions

While expert panel methodology has been used in autism research [17], our approach of combining community and researcher perspectives in parallel panels provided unique insights into the different priorities and constraints faced by various stakeholders.

The focused stakeholder representation (eight participants) allowed for in-depth exploration of themes while maintaining manageable group dynamics. This approach may be particularly valuable in contexts where autism community organizing is still developing and where intimate dialogue may be more culturally appropriate than large-scale forums.

6. Proposed Framework for Culturally Responsive Autism Research

Based on the synthesis of panel discussions and alignment with existing literature, we propose a comprehensive four-pillar framework for bridging the gap between autism research and community needs:



The PACA Framework

Participatory • Adaptive • Communicative • Accountable

Pillar 1:
Participatory Design

Engage community stakeholders as equal partners throughout all research phases, from initial priority-setting through dissemination and implementation. This includes:

- Community advisory boards with decision-making power
- Co-researcher positions for community members
- Shared ownership of research outcomes
- Flexible methodologies accommodating diverse participation styles

Pillar 2:
Cultural Contextualization

Adapt research approaches, tools, and interventions to reflect specific cultural norms, values, and linguistic contexts. This includes:

- Culturally adapted assessment and intervention tools
- Arabic-language resource development
- Integration of cultural values and family structures
- Collaboration with local cultural experts

Pillar 3:
Accessible Dissemination

Share research outcomes through multiple accessible formats that reach diverse community members. This includes:

- Plain language summaries in Arabic and English
- Visual and multimedia resources
- Community workshops and presentations
- Integration with existing support networks

Pillar 4:
Accountability and Feedback

Establish structured mechanisms for ongoing feedback, evaluation, and adaptation based on community input and real-world impact. This includes:

- Regular community feedback sessions
- Impact measurement from community perspectives
- Iterative research design based on feedback
- Long-term relationship building and maintenance

Figure 1. The PACA Framework

6.1 Implementation Strategies

Successful implementation of the PACA framework requires systematic changes at multiple levels:

Level	Strategy	Key Actions
Individual Researcher	Capacity Building	Training in participatory methods, cultural competency, accessible communication
Institutional	Policy Reform	Tenure criteria including community impact, funding for community engagement
Funding Agency	Priority Setting	Community engagement requirements, long-term relationship funding
Community	Capacity Development	Research literacy programs, leadership development, advocacy training

7. Limitations

Several limitations should be considered when interpreting these findings. The study involved a relatively small number of participants (n=8) from a single conference context, which may limit generalizability. However, the focused expert panel approach allowed for in-depth exploration of themes and is appropriate for framework development research.

The geographic focus on Qatar and the Arab region may limit applicability to other cultural contexts, though the underlying principles may be transferable. Additionally, the conference setting may have influenced participant responses, potentially emphasizing positive aspects of technology and innovation.

Future research should validate the proposed framework through implementation studies and expand the geographic and cultural scope of stakeholder consultation. Longitudinal studies examining the impact of framework implementation on research outcomes and community satisfaction would strengthen the evidence base.

8. Conclusions

This study presents a potential participatory framework for culturally responsive autism research that addresses critical gaps between academic research and community needs. The PACA framework (Participatory, Adaptive, Communicative, Accountable) provides a practical roadmap for researchers and institutions seeking to develop more inclusive and impactful research approaches.

The regional focus on the Arab context highlights the importance of cultural adaptation in autism research and demonstrates how local expertise can contribute to global knowledge. The collaborative involvement of established researchers like Dena Al-Thani and Achraf Othman, who have pioneered participatory approaches in regional autism and assistive technology research, provides a strong foundation for implementation.

Moving forward, successful implementation of this framework will require sustained commitment from multiple stakeholders, including researchers, institutions, funding agencies, and community organizations. The potential benefits—more relevant research, improved services, and enhanced quality of life for autistic individuals and families—justify the investment required for this transformation.

As the autism research field continues to evolve, frameworks like PACA can help ensure that this evolution is guided by community voices and cultural wisdom, ultimately creating a more inclusive and effective research ecosystem that serves all members of the autism community.

9. Acknowledgments

We thank all panel participants for their generous contribution of time and expertise. Special acknowledgment goes to the self-advocate and parent participants who shared their personal experiences and insights. We also thank the AutismTech 2025 organizing committee for providing the platform for these important discussions.

References

1. M. J. Maenner, 'Prevalence and characteristics of autism spectrum disorder among children aged 8 years—autism and developmental disabilities monitoring network, 11 sites, United States, 2018', MMWR Surveill. Summ., vol. 70, 2021.
2. E. Pellicano, A. Dinsmore, and T. Charman, 'Views on researcher-community engagement in autism research in the United Kingdom: A mixed-methods study', PLoS One, vol. 9, no. 10, p. e109946, 2014.
3. D. Al Thani, A. Hassan, H. Chalghoumi, A. Othman, and S. Hammad, 'Addressing the Digital Gap for the Older Persons and their caregivers in the State of Qatar: A Stakeholders' Perspective', in 2021 8th International Conference on ICT & Accessibility (ICTA), IEEE, 2021, pp. 01–06.
4. S. Soto, K. Linas, D. Jacobstein, M. Biel, T. Migdal, and B. J. Anthony, 'A review of cultural adaptations of screening tools for autism spectrum disorders', Autism, vol. 19, no. 6, pp. 646–661, 2015.
5. M. Bahameish, D. Al-Thani, M. Qaraqe, and C. Montag, 'Autistic Traits and Internet Use Disorder Tendencies in the Middle East: Insights from Qatar', J. Technol. Behav. Sci., pp. 1–16, 2025.
6. H. Hussein, G. R. Taha, and A. Almanasef, 'Characteristics of autism spectrum disorders in a sample of egyptian and saudi patients: transcultural cross sectional study', Child Adolesc. Psychiatry Ment. Health, vol. 5, no. 1, p. 34, 2011.
7. M. H. F. Hijab, B. Banire, J. Neves, M. Qaraqe, A. Othman, and D. Al-Thani, 'Co-design of technology involving autistic children: A systematic literature review', Int. J. Human–Computer Interact., vol. 40, no. 22, pp. 7498–7516, 2024.
8. A. Othman et al., 'Accessible Metaverse: A theoretical framework for accessibility and inclusion in the Metaverse', Multimodal Technol. Interact., vol. 8, no. 3, p. 21, 2024.
9. C. Y. Zhang and K. Chemnad, 'Is the metaverse accessible? An expert opinion', Nafath, vol. 9, no. 25, 2024, Accessed: Aug. 25, 2025. [Online]. Available: https://nafath.mada.org.qa/nafath-article/mcn2507/
10. A. Lahiri, A. Othman, D. A. Al-Thani, and A. Al-Tamimi, 'Mada Accessibility and Assistive Technology Glossary: A Digital Resource of Specialized Terms', in ICCHP, 2020, p. 207.
11. L. Roche, D. Adams, and M. Clark, 'Research priorities of the autism community: A systematic review of key stakeholder perspectives', Autism, vol. 25, no. 2, pp. 336–348, 2021.
12. H. Pickard, E. Pellicano, J. Den Houting, and L. Crane, 'Participatory autism research: Early career and established researchers' views and experiences', Autism, vol. 26, no. 1, pp. 75–87, 2022.
13. J. Den Houting, J. Higgins, K. Isaacs, J. Mahony, and E. Pellicano, '"I'm not just a guinea pig": Academic and community perceptions of participatory autism research', Autism, vol. 25, no. 1, pp. 148–163, 2021.
14. M. H. F. Hijab et al., 'Let's join the toy inventors: designing an inclusive collaborative play toy with and for autistic children', CoDesign, pp. 1–36, 2025.
15. T. S. Al Maskari, C. A. Melville, and D. S. Willis, 'Systematic review: cultural adaptation and feasibility of screening for autism in non-English speaking countries', Int. J. Ment. Health Syst., vol. 12, no. 1, p. 22, 2018.
16. V. Braun and V. Clarke, 'Using thematic analysis in psychology', Qual. Res. Psychol., vol. 3, no. 2, pp. 77–101, 2006.
17. T. W. Benevides et al., 'Listening to the autistic voice: Mental health priorities to guide research and practice in autism from a stakeholder-driven project', Autism, vol. 24, no. 4, pp. 822–833, 2020.

Mada ICT-AID OER Hub

Recognizing the pivotal role that Open Educational Resources OE[i] have, providing equally effective access to learning opportunities for all, Mada has joined the growing worldwide OER movement and pledges as such to promote OER accessibility harnessing the power of inclusive ICTs so that educational resources are accessible for all.

With this in view, Mada launched the "Mada ICT-AID OER Hub"[1] to be a Global knowledge hub featuring freely accessible resources toward closing the training and knowledge gap in ICT Accessibility.

Mada Hub contains collections of accessible open educational resources, which are aligned to the "Mada ICT Accessibility and Inclusive Design (ICT-AID) Competency Framework"[2]. These resources are aggregated, curated and managed by Mada and partners, through collections, and groups, and development tools available on the Hub.

The community of ICT accessibility professionals, experts, advocates, educators, and learners can discover, create, and share accessible quality open content, and connect with others to expand their capabilities and improve inclusive practices.

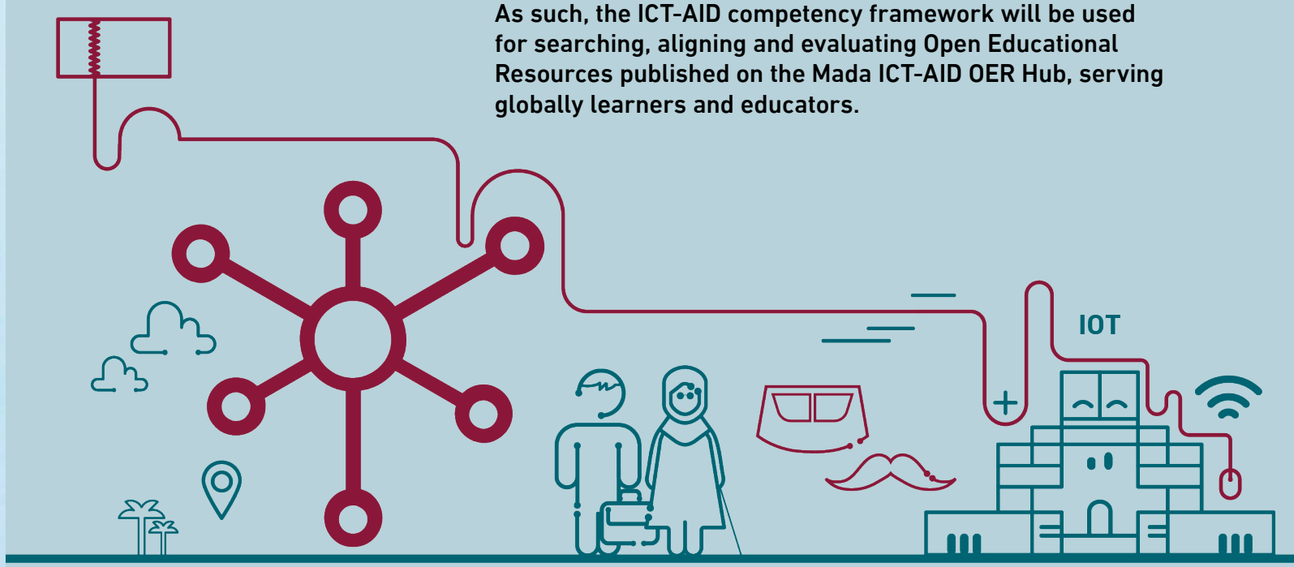
The Mada ICT-AID OER Hub is meant to be a centralized and searchable repository of ICT-AID aligned educational and training materials to help the community in Qatar and beyond, locating and accessing appropriate OER related to ICT accessibility. In that vein, Mada ICT Accessibility and Inclusive Design competency framework is featured as a standard available to users of the OER Commons[3] digital library and collaboration platform. As a standard, Mada ICT-AID will be used to index and describe ICT-AID aligned OER providing accordingly ease of access and retrieval of these resources. As such, the ICT-AID competency framework will be used for searching, aligning and evaluating Open Educational Resources published on the Mada ICT-AID OER Hub, serving globally learners and educators.

[1]https://oer.mada.org.qa/

[2]https://ictaid.mada.org.qa/

[3]https://www.oercommons.org/

[i] Open Educational resources (OER) are "learning, teaching and research materials in any format and medium that reside in the public domain or are under copyright that have been released under an open license, that permit no-cost access, re-use, re-purpose, adaptation and redistribution by others" .



Tamim & Reem

An Arab Platform Reshaping the Future of Education for Deaf Children

Ma'moun Odeh
mamoun@tameemreem.com
Heba Jamjoum
heba@tameemreem.com

Tameem & Reem
Jordan, Amman

Zakaria Jamjoum
zakaria@tameemreem.com

Turkey, Istanbul

Abstract - Tamim and Reem is the first innovative educational platform in the Arab world specifically designed for children with hearing disabilities between the ages of 3 and 12. The platform seeks to bridge the significant gap in their education by providing content both in Arabic and sign language, enabling children to learn in their native language in a visually engaging way. The platform integrates education, entertainment, and modern technology, offering interactive educational curricula, 3D animated content, stories translated into sign language, and educational games based on visual interaction and stimulation.

The platform's impact extends beyond children to families and teachers, providing them with educational and visual tools that enhance effective communication and support the inclusion of deaf children in an inclusive learning environment. Through a Learning Management System (LMS), a mobile application, and a responsive website, educational resources can be easily accessed anytime, anywhere. The project aims to bring about a qualitative and sustainable change in the education of deaf children by building a more inclusive environment that supports their right to learn and grow.

Keywords: Deaf Education; Sign Language; Inclusive Learning; Assistive Technology; Tamim and Reem; Children with Hearing Impairments; Deaf Children; Arabic Language Education.

1. Introduction

1.1 The Situation in the Arab World

Every child has the right to learn in their own language, yet millions of deaf children still lack this basic right. Although these children possess the same abilities and aspirations as their peers, the educational reality poses significant barriers to their education, including poor academic achievement and a low chance of completing secondary education, with the percentage remaining extremely low compared to others [1], [2].

1.2 The Situation in Jordan

As for Jordan, approximately 200,000 people over the age of five are hearing impaired, representing 3.1% of the population [2]. Despite this, the educational challenges facing these children remain significant, ranging from poor Arabic language skills [3] and a lack of dedicated curricula to high school dropout rates.

Based on this reality, the "Tamim and Reem" platform was created, the first bilingual Arab educational platform (sign language and Arabic), specifically designed to meet the needs of deaf children and provide them with a new opportunity for learning and integration.

2. The Story Behind the Innovation

2.1 The Beginning with Ma'moun Odeh

The story began with Ma'moun Odeh, a young Jordanian man born deaf in an environment unprepared to meet his educational needs. He couldn't find a book in his language, nor any visual content that reflected his reality, but he decided to turn this challenge into an opportunity. Through four years of self-study, Ma'moun mastered the art of designing and animating 3D cartoon characters using 3D Blender and other tools, creating visual content that deaf children could understand.

What's unique about this project is that it's led by a deaf pioneer who lived the experience in every detail, giving it an authenticity and exceptional value unmatched by any other initiative. Ma'moun wasn't just a developer or designer; he was a voice from within the community, fully aware of what deaf children need to feel included and understood.

2.2 The Role of Heba Jamjoum and the Family

Alongside Ma'moun was his wife, Heba Jamjoum, who learned sign language out of a love and desire to communicate with him. She later obtained a Trainer of Trainers (TOT) certificate. With the birth of their two children, Tamim and Reem, it was only natural for them to learn sign language to communicate with their father. From there, the family story transformed into a pioneering project bearing the names of their two children, Tamim and Reem, not only as a symbol of the family, but also because their names are composed of labial letters that are easy for deaf children to pronounce and clearly visualize, making them more relatable and simpler for them. This project represents a dream to change the reality of millions of deaf children.

3. The Team

The project is led by Ma'moun Odeh and Hiba Jamjoum, with the participation of their children, Tamim (8 years old) and Reem (5 years old). The family contributed directly to the development of the educational content. Ma'moun, being deaf, drew on his experience and expertise to design and animate the cartoon characters, while Hiba was responsible for scriptwriting, directing, and editing. The children also participated in recording some of the voices, giving the content an authentic spirit relatable to children. This integration of personal and family experience contributed to enhancing the project's credibility and making the content more appropriate and realistic for deaf children.

4. Methodology and Piloting Phase

The "Tamim and Reem" team adopted a participatory methodology based on engaging the target group from the earliest stages. To achieve this, the team conducted a field study using a descriptive survey approach, relying on questionnaires and field visits to specialized Jordanian schools. The sample included 37 teachers, 34 mothers, and 6 sign language interpreters. The aim was to understand the educational challenges faced by deaf children and link them to available curricula and educational resources.

Based on the results of this study, a pilot program for the platform was designed, involving more than 30 deaf children between the ages of 3 and 12, along with a group of parents and teachers. Eight field sessions were conducted, including practical activities using the platform and application, followed by discussion sessions to gather feedback. The evaluation focused on ease of use, the suitability of sign language, and the level of children's engagement with the visual activities.

This field-based methodology helped ensure that the platform's final product was precisely tailored to the target audience and reflected their real educational needs, enhancing its academic quality and societal depth.

5. From a Small Initiative to a Fully Integrated Platform

The project began as a YouTube channel in 2022, offering bilingual (sign language and Arabic) animated content for children. Within a short period, the channel attracted tens of thousands of views and thousands of subscribers, reflecting the community's thirst for specialized content translated into sign language.

The idea evolved into a fully integrated educational platform that includes a wide range of components, including interactive bilingual educational curricula specifically designed for deaf children, high-quality 3D animated content, and children's stories translated into sign language to enhance understanding and communication. The platform also offers educational games based on visual interaction and reward motivation, along with a Learning Management System (LMS) to track students' progress. It also features a mobile application and a responsive website that facilitate access to content from anywhere, anytime.

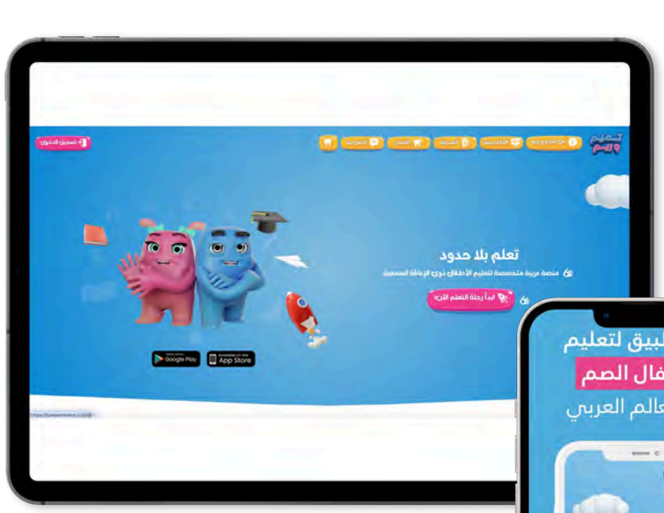


Figure 1. Home page of the Tamim & Reem platform

Figure 2. Images from the mobile app

6. Technical Preview

The platform was developed using the latest digital technologies to ensure ease of use and stable performance. A simplified visual interface was designed to suit deaf children, and frequent testing was conducted on various devices to ensure the platform is safe, stable, and accessible for all.

7. Challenges Along the Way

The journey was not easy. The team faced several key challenges along the way. There were no similar Arabic platforms offering educational content specifically for deaf children. There was also a lack of resources and data, as sufficient, reliable educational references were not available to build curricula. Furthermore, as a deaf person, Ma'moun had to rely on self-learning through visual and experiential learning to learn animation, a significant challenge in itself. Finally, the team faced a lack of international cooperation, as they received no response from the foreign platforms they contacted, forcing them to rely entirely on local efforts.

Despite these challenges, the platform has become a model of innovation and perseverance.

8. User Testing

From the early stages, the team was keen to involve the target audience in the testing process. Deaf children demonstrated clear engagement with the platform, which helped them improve their linguistic knowledge and ability to link Arabic to sign language. Parents confirmed that the platform opened a new window for them to communicate with their children in more effective ways, while teachers considered it an innovative tool that supports the educational process and adds value to classes. Dozens of volunteers, translators, and experts also contributed by providing feedback and comments, making the platform more inclusive and accurate.

9. Impact

The impact of the "Tamim and Reem" platform was multidimensional. It provided deaf children with a safe learning environment that speaks their language, boosting their self-confidence and increasing their ability to learn independently. It also provided speaking children with the opportunity to learn sign language, which helped promote communication with their deaf peers. On the family level, the platform provided parents with powerful visual tools to communicate more effectively with their children, while teachers viewed it as a supportive tool that enhances traditional education and adds innovative resources to classrooms.

10. Media Coverage

The project received extensive coverage from local and international media outlets, which contributed to strengthening its presence and giving it greater credibility with partners and supporters. The Jordanian newspaper Al-Ghad published extensive articles about the initiative [4], while Amman TV featured the story in one of its programs. TRT Arabic also highlighted the experience as one of the inspiring initiatives in the region. In addition, other media platforms such as AJ+, Jordan TV, Al-Mamlaka TV, Reuters, and local platforms such as Beit Hawa, Sahat, and the King Abdullah II Fund covered the project in their various reports, enabling its story to reach a wide and diverse audience.

11. The Role of Mada Center and Future Vision

Mada Center's financial, technical, and media support has helped improve the platform's quality and ensure its reach to a wider segment of children, parents, and teachers. The impact of this support is not limited to the current phase, but extends to enhancing the project's future vision. "Tamim and Reem" is not just an educational platform; it is a movement for change aimed at reshaping the future of education for deaf children in the region. In the next phase, the team seeks to expand regionally to reach every deaf child in the Arab world, while developing specialized educational curricula and life skills, integrating artificial intelligence tools to support instant translation and customize learning to suit each child's needs, and building strategic partnerships with ministries of education and Arab children's entities.

12. Conclusion

What began as a small family story between Ma'moun, Heba, Tamim, and Reem has today transformed into a pioneering Arab project that restores hope to millions of deaf children. "Tamim and Reem" is not just an educational platform, but an Arab dream led by a deaf pioneer to prove that disability is not the end, but rather the beginning of an innovation that changes reality and gives children the opportunity to learn and thrive.

Figure 3. Behind the scenes of educational content production

References

1. Department of Statistics, “The Reality of Disability ‘Functional Difficulties’ in Jordan, based on the data of The General Population and Housing Census 2015,” Amman, Jordan, 2021. Accessed: Sep. 24, 2025. [Online]. Available: https://dosweb.dos.gov.jo/DataBank/Analytical_Reports/Disability_2021.pdf
2. “Jordan The world joins the celebration of the International Day of Persons with Disabilities | The Higher Population Council." Accessed: Sep. 24, 2025. [Online]. Available: https://tinyurl.com/58textvy
3. Shreen Hussein, “Shreen Hussien: Jordanian Deaf Role Model.,” Deaf Unity. Accessed: Sep. 24, 2025. [Online]. Available: https://deafunity.org/article_interview/shreen-hussien-jordanian-deaf-role-model/?utm_source=chatgpt.com
4. Ibrahim Al-Mubaydeen, "A platform for people with hearing disabilities with educational cartoon content.," Al-Ghad. Accessed: Sep. 24, 2025. [Online]. Available: https://tinyurl.com/2wnn2njn

Mada ICT accessibility and inclusive design ICT-AID competency framework

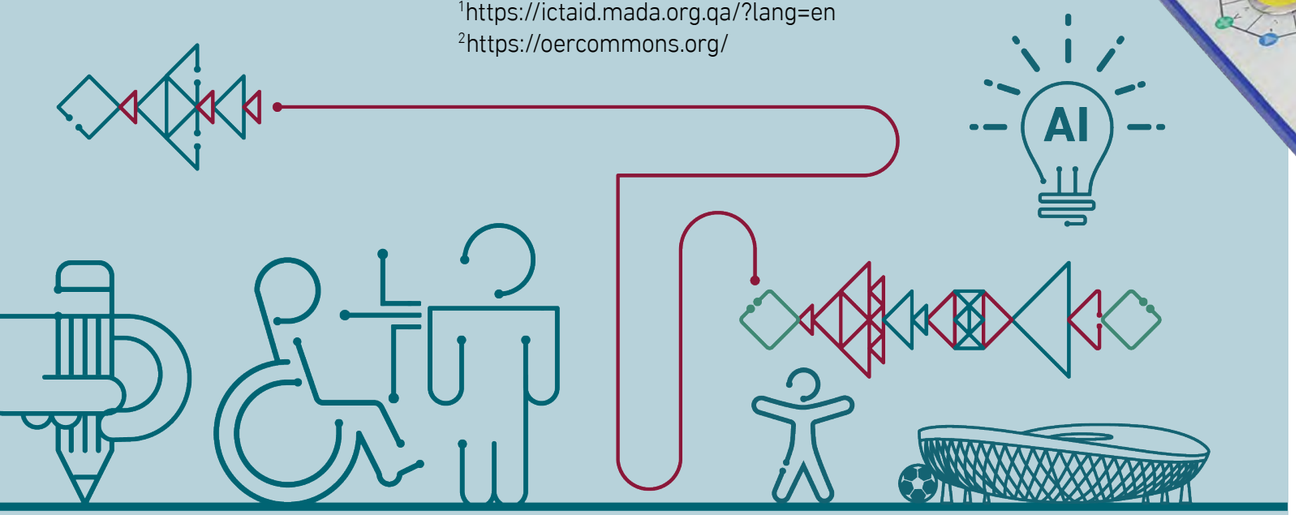
Mada ICT accessibility and inclusive design (ICT-AID) competency framework describes all the relevant ICT accessibility competencies and capabilities required for students, teachers, and professionals to use and develop accessible products, contents, and services.

The framework features six domains of competencies, each domain covers a set of competencies, each of which is broken down into capabilities, required to apply, evaluate, and remediate digital accessibility in compliance with accessibility standards and best practices.

Mada ICT-AID Competency Framework can be used as a tool to guide professional education services, universities and individuals on delimiting the required relevant competencies in ICT accessibility and fostering the integration of ICT Accessibility in education curricula and training programmes. The framework can be also adapted for use in different learning contexts and modes, and availed to develop, describe, and publish ICT-AID aligned resources in courseware repositories.

Mada framework is featured as an education standard available to users of the Open Educational Resources OER Commons digital library and collaboration platform. As such, the framework can be used to index, align, and search OER providing accordingly ease of access and retrieval of these resources, serving globally learners and educators.

[1]https://ictaid.mada.org.qa/?lang=en
[2]https://oercommons.org/



Nafath
Issue 30

45

A Case Study on Key2enable's Literacy Lab

Using Assistive Technology as a Transitional Tool for Inclusive Education

Sabrin Shaikh

Key2enable
Assistive Technology MENA Ltd, UAE
sabrin@key2enable.ae
Inclusion Coordinator
Research, Training & Accessibility

Yusra Sayed

Key2enable
Assistive Technology MENA Ltd, UAE
yusra@key2enable.ae
Psychologist and Head of Learning and Accessibility

Ernest Sahakyan

Key2enable
Assistive Technology MENA Ltd, UAE
ernest@key2enable.com
Chief Operations Officer

Tatevik Muradyan

Key2enable
Assistive Technology MENA Ltd, UAE
tatevmuradyan.speechtherapy@gmail.com
Speech Therapist & Special Educator

Abstract - This case study examines the transformative impact of Key2Enable's Literacy Lab in promoting inclusive education through the utilization of assistive technology. Implemented over four months with fifty students with disabilities in the UAE, the Literacy Lab demonstrated remarkable improvements in student attendance, academic performance, communication skills, and social-emotional development. The intervention integrated Key2Enable's Assistive Technology, family engagement strategies, and multisensory digital learning activities to bridge educational gaps. By June, over 90% of students consistently attended sessions and showed significant gains in literacy and comprehension. The program's human-centered approach—emphasizing student-led independent learning, peer learning, and emotional expression—offers a compelling model for inclusive education in the Arab region and beyond.

1. Introduction

In today's evolving educational landscape, inclusive technology has become a vital enabler for equitable learning, especially for students with disabilities. Globally—and increasingly within the Arab region—there is a growing recognition that education must be designed to accommodate learner diversity, not expect learners to adapt to rigid systems. Assistive technology plays a pivotal role in bridging this gap, offering students with intellectual and physical disabilities the tools to communicate, participate, and thrive.

In the United Arab Emirates, this shift toward inclusive innovation aligns with the country's National Policy for Empowering People of Determination and the UAE's Inclusive Education Framework (2017), which seeks to ensure that all learners have access to quality education in mainstream as well as inclusive educational settings. Under the directives of His Highness Sheikh Mohammed bin Rashid Al Maktoum, and through legislation such as Federal Law No. 29 of 2006 on the Rights of People of Determination, the UAE has laid a strong legal and ethical foundation for inclusive education.

This commitment is further reflected in the implementation of two fully operational Literacy Labs in Abu Dhabi, located within the Zayed Higher Organization for People of Determination (ZHO). As part of a strategic partnership with Key2enable, these Labs serve as pioneering centers for accessible education, where assistive tools like the Key-X device and the Expressia platform enable students to engage meaningfully in literacy, communication, and emotional development.

Keywords: Inclusive education, assistive technology, Literacy Lab, Key2enable, special education, accessibility, digital inclusion, parental engagement, multisensory learning

The initiative is not only well-resourced but also actively supported, monitored, and quality-assured by the Abu Dhabi Government and ZHO leadership. Regular assessments, progress tracking, and institutional support mechanisms ensure that the Labs are aligned with national goals and deliver measurable impact.

This case study examines the outcomes of the Literacy Lab model over four months, evaluating the impact of integrating inclusive technologies, multisensory instruction, and family engagement on student progress across academic, behavioral, and social domains. By comparing pre- and post-intervention data, this study demonstrates how inclusive education—when anchored in the right tools, vision, and community—can drive meaningful transformation in the lives of students with disabilities.

The Lab also provides comprehensive pre-employment and employability training for students with physical and motor disabilities. The curriculum includes practical instruction on using key government digital services—specifically the ICP Platform and TAMM Portal—to perform essential tasks such as updating their Emirates ID and accessing other UAE e-government services.

A critical component of this training is the deployment of our proprietary adaptive technology, the Key-X alternative keyboard. This tool is instrumental in enabling students with strong intellectual capacity but significant physical limitations to use computers effectively, navigate the internet, and achieve digital literacy.

While this initiative is currently demonstrating significant positive outcomes, a formal longitudinal study is planned for a subsequent phase. This future research will adopt a multi-domain framework to assess the journey of the students, their parents, and caregivers, measuring the program's long-term impact quantitatively and qualitatively on independence, employability, and quality of life.

The Literacy Lab is more than just a classroom, it represents a transitional ecosystem that continuously connects research, technology, and community to support the evolving needs of students with disabilities. It offers a scalable and culturally grounded model for inclusive education, reflecting the UAE's vision of a barrier-free, knowledge-driven society where every learner has the tools to succeed.

In doing so, it exemplifies how evidence-based innovation can be transformed into real-world impact—where inclusive design, lived experience, and digital solutions converge to remove barriers and unlock human potential.

2. Literature Review

Inclusive education has evolved from a conceptual ideal to an actionable framework that requires systemic change in pedagogy, policy, and technology. At its core, inclusive education advocates for the right of every learner—regardless of physical, cognitive, or sensory disabilities—to access meaningful, equitable learning opportunities within mainstream settings (UNESCO, 2023). This philosophy challenges traditional segregated models and calls for educational environments that are flexible, responsive, and accessible.

Central to the success of inclusive education is the integration of assistive technology (AT), which catalyzes overcoming barriers posed by

disabilities. Assistive technologies encompass a broad range of devices and software designed to support communication, mobility, learning, and independence. For students with physical disabilities, tools such as switch-accessible keyboards and eye-tracking devices enable interaction with digital content that would otherwise be inaccessible (Alnahdi, 2014). For those with intellectual or communication impairments, augmentative and alternative communication (AAC) systems facilitate expressive and receptive language development, which are essential for academic and social participation (Beukelman & Light, 2020).

The Universal Design for Learning (UDL) framework, proposed by CAST (2018), provides foundational principles for designing flexible learning environments that accommodate learner variability. UDL emphasizes multiple means of representation, expression, and engagement, which align closely with the multisensory and personalized approaches used in assistive technology interventions. Research shows that incorporating UDL and AT can significantly improve literacy outcomes among learners with disabilities by providing alternative pathways to access curriculum content and demonstrating knowledge (Troshina et al., 2021).

In the context of the MENA region, however, the implementation of inclusive education faces unique challenges. These include limited availability of culturally and linguistically relevant AT, insufficient teacher training, and social stigma surrounding disabilities (United Nations Educational, Scientific and Cultural Organization (UNESCO), 2023). Additionally, many mainstream schools lack the infrastructural support necessary for the effective deployment of AT solutions. Despite these barriers, recent policy advancements in countries like the UAE signal a strong commitment to inclusion. The UAE's National Policy for Empowering People of Determination (2017) and Federal Law No. 29 (2006) articulate clear mandates for educational access and the use of modern technologies to support learners with disabilities. These frameworks create enabling environments for programs such as Key2Enable's Literacy Lab to thrive.

Empirical studies corroborate the positive effects of AT-driven literacy interventions. For instance, learners using switch-accessible keyboards coupled with symbol-supported software demonstrated improved engagement, motivation, and academic achievement compared to traditional methods (Schaefer & Andzik, 2016). Peer tutoring and self-advocacy—two key elements integrated into the Literacy Lab—are also well-documented as effective strategies in special education. Peer-assisted learning encourages social inclusion and reinforces skill acquisition through collaborative interaction, while self-advocacy empowers students to take ownership of their educational journeys (Makoelle, 2016).

Furthermore, family involvement is critical to reinforcing learning gains. Studies indicate that regular communication between educators and families, supported by digital platforms like WhatsApp or video sharing, strengthens home-based practice and promotes consistency in intervention (Jigyel et al., 2018). This aligns with the parental engagement model used in the Literacy Lab, which saw a progressive increase in involvement over the four months.

The multisensory learning activities incorporated in the Literacy Lab—such as sand tracing, songs, and visual emotion boards—reflect research emphasizing the importance of engaging multiple senses to enhance memory, comprehension, and motivation in learners with disabilities (Rahmatullah, 2024). Such approaches are particularly effective for students with intellectual disabilities who benefit from concrete, experiential learning.

Collectively, the literature underscores that inclusive education is most successful when it integrates assistive technology, culturally responsive pedagogy, family involvement, and community support within a framework of continuous monitoring and adaptation. The Literacy Lab represents a synthesis of these best practices, localized to the UAE context, and thus contributes important insights into how research-driven innovation can be translated into meaningful, scalable community impact.

2.1 Scope of the Study

This case study examines the measurable differences in student performance, engagement, and developmental outcomes before and after the implementation of Key2Enable's Literacy Lab. Over four months, fifty students with intellectual, motor, and physical limitations were observed at the Zayed Higher Organization, Centre for Rehabilitation & Care, Abu Dhabi, UAE.

The scope of the work includes:

- Pre- and post-assessment of literacy and comprehension skills
- Changes in attendance and classroom engagement in students
- Socio-emotional development tracked through visual tools.
- Levels of parental involvement before and after structured engagement strategies
- The impact of Key-X and Expressia as core assistive technology tools in enabling student participation and communication in an inclusive learning space.
- Determining themes for a qualitative study using Key informant interviews and unstructured interviews with parents. Classroom observations and video-recorded observations, specialists' logs. etc.

3. Methodology

The Literacy Lab case study was implemented over four months with a cohort of fifty students with disabilities in the UAE. Participants were selected in collaboration with partner schools to ensure a diverse representation of learning needs, including physical, intellectual, and communication-related disabilities.

The Literacy Lab integrated the following strategies:

- Assistive technology tools (Key-X and Expressia) to support digital access and literacy development.
- Multisensory learning activities to strengthen comprehension and engagement.
- Family engagement strategies encouraged active participation from parents and caregivers.

3.1 Data collection

Multiple sources of data were gathered to capture both academic and behavioral outcomes:

- Attendance tracking,
- Academic progress monitoring (literacy and comprehension assessments),
- Observation of communication and social-emotional interactions, and
- Feedback, Observations, and Logs from teachers, families, and students' performance reports.

This mixed-methods approach combined quantitative indicators (attendance rates, literacy scores) with qualitative insights (observed behaviors, participant testimonies, specialist logs).

3.2 Participants

The study involved 50 students aged 6–18+ years with various intellectual and physical disabilities enrolled in Zayed Higher organization, Centre for rehabilitation and care in Abu Dhabi, UAE. Students came from diverse learning backgrounds and levels of support. Educators, therapists, and families were also involved as stakeholders in the intervention.

3.3 Study Design

The study followed a three-phase design:

- **Pre-test phase (Baseline, March):** Initial academic assessments, attendance logs, and behavioral observations were conducted at the onset of the Literacy Lab implementation.
- **Intervention phase (March–June):** Over four months, students participated in Literacy Lab programming that integrated Key2Enable's assistive technology tools with a multisensory teaching curriculum.
- **Post-test phase (Final month):** Follow-up assessments, attendance tracking, and behavioral observations were completed, alongside family interviews to gather feedback and measure outcomes.

3.4 Instruments Used

At the core of the Literacy Lab's assistive technology ecosystem were Key-X and Expressia—two innovative tools developed by Key2enable and designed to be accessible for students with a wide range of physical and cognitive disabilities. These tools served as the nucleus of all instructional activities, enabling inclusive participation, communication, and personalized learning.

- **Key-X:** A multifunctional, switch-accessible keyboard device designed for students with motor challenges. It allowed users to interact with digital content through touch, switches, or external input methods. In the Literacy Lab, students used Key-X for typing, selecting answers, controlling learning apps, and engaging in writing tasks independently.
- **Expressia:** A customizable, symbol-supported communication and learning platform. Expressia was used to design interactive lessons, create personalized communication boards, and deliver story-based comprehension activities. Its visual, auditory, and tactile features helped bridge communication gaps and support expressive language development.

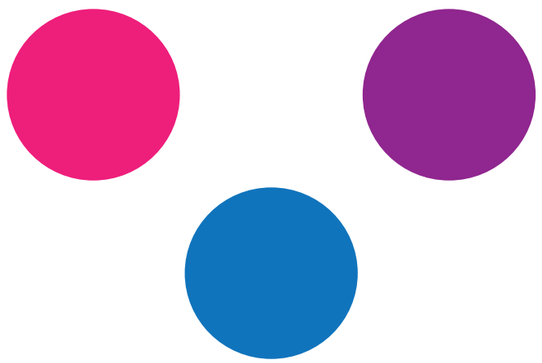
These core tools were supported by:

- Self-advocacy exercises through Expressia to encourage independent learning.

- Emotion boards for daily social-emotional check-ins
- Using stickers and rewards for positive reinforcement
- Visual schedules and AAC support for task organization
- Multisensory materials (e.g., sand tracing trays, phonics cards, and songs) to reinforce literacy and numeracy.
- Interview methods, observation logs by specialists, interactive dashboards, and communications for bi-weekly check-ins with parents and teachers.

3.5 Data Analysis

Quantitative data were analyzed using graphical and percentage comparisons of pre- and post-test scores, along with attendance trends. Qualitative data - including video observations, teacher notes, and parent feedback, were thematically coded to identify patterns in student behavior, communication, and emotional growth. The analysis specifically compared academic performance, attendance rates, and parental engagement before and after the Literacy Lab intervention, with additional attention to story-based assessment outcomes and aggregate class performance in literacy and cognitive skills.



4. Results

The outcomes of the Literacy Lab were captured through both quantitative measures and qualitative observations, providing a holistic view of its impact. From March to June, the four-month Literacy Lab intervention yielded measurable improvements in student learning and engagement.

4.1 Quantitative Results

Between March and June, students demonstrated measurable progress across multiple domains:

- Visible Improvement in Academic Performance and Average Class Performance in terms of Literacy and Cognitive Skills, measured by monthly assessments and progress reports.
- Improved story comprehension skills, measured through story-based and text-recognition assessments.
- Enhanced attendance in classrooms, including greater confidence in self-expression.
- Positive parental engagement, observed through parent-teacher collaboration, more awareness, and more active engagement during group communications.

Teachers also reported reduced dependency on individualized support and greater integration of students into classroom activities.

Observations in Academic Performance:

The distribution of student assessment scores showed substantial improvement from March (Pre-Intervention) to June (Post Intervention) as depicted in Figure 1. In March, most students (90%) scored below 70%. Only 10% of students achieved a score of 70% or higher.

In April, performance improved significantly. The proportion of students scoring below 70% fell to 20%, while 60% of students scored in the 70-89% range. A further 20% of students scored in the 90-100% range.

From May onwards, performance stabilized at a high level. In both May and June, approximately 75% of students scored in the 90-100% range. The remaining students were primarily in the 70-89% range, with only a small minority (4-5%) scoring below 70%.

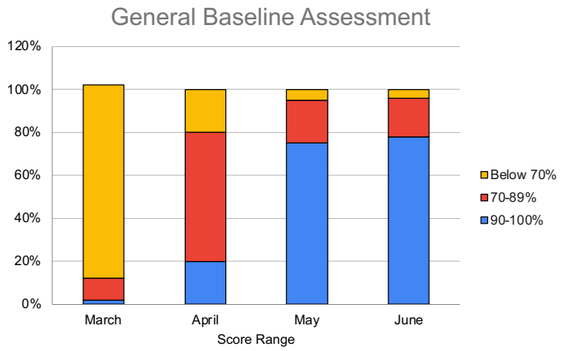


Figure 1. Data showing the cumulative academic performance of students.

Observation in Attendance Rates

Attendance increased significantly over the four months.

- Baseline average (Pre-Lab): Approximately 65%
- Final average (Post-Lab): Over 90%

This improvement reflects not only stronger student engagement but also heightened family involvement in supporting consistent participation.

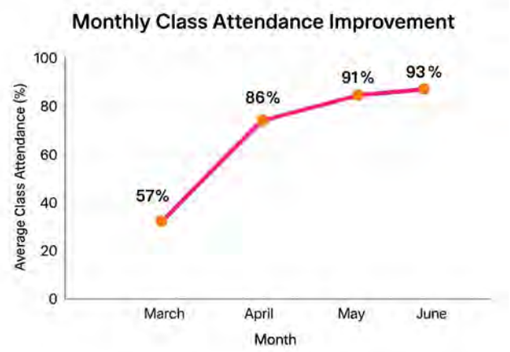


Figure 2. Data showing the Average Class Attendance Percentage

Story Comprehension Outcomes (Post-Test)

Post-test assessments revealed three distinct performance bands:

- **Proficient & Above (43%):** Nearly half the class demonstrated mastery of story comprehension, achieving scores above 90%.
- **Proficient with Support (36%):** Over one-third of students were close to mastery, requiring only minimal support to reach the highest proficiency level.
- **Needs Assistance (21%):** A smaller group scored below 70%, highlighting the need for targeted instructional interventions.

Key Ratio: 79% (43% + 36%) of the class is performing at or near the target proficiency level (70%+). This is a positive outcome, showing the instruction was effective for the majority.

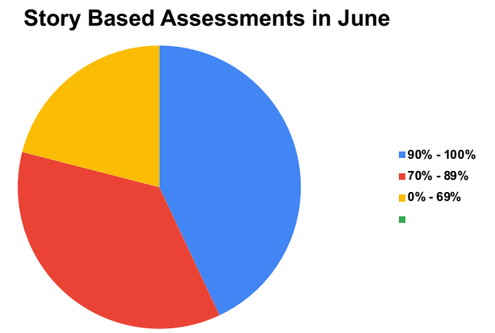


Figure 3. Data showing the results of story-based assessments.

Observation in Parental Engagement

- **Pre-intervention:** Before March, Parents were hardly involved with the teachers and their child's learning journey, but it began with a big leap of 50% in engagement in March.
- **Post-intervention:** 90% of parents were actively engaged through WhatsApp, at-home reinforcement, and video feedback loops.

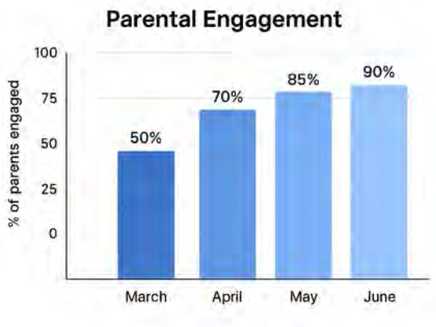


Figure 4. Data showing the progress of parental engagement from March to June

Observations in Literacy & Cognitive Skills

Assessment data from March to June indicated notable gains across literacy and cognitive domains:

- **Strong overall progress:** The class average increased by 58.2%, reaching a final mean score of 87%.
- **Top-performing skill:** Numbers learned achieved the highest mastery level, with 93% proficiency.
- **Most improved skill:** Story comprehension showed the greatest growth, with an 87% increase, reflecting the effectiveness of instructional strategies in this area.
- **Area requiring focus:** Colors identified emerged as a statistical outlier, with the lowest final mastery (79%) and the smallest growth (27.4%), falling short of the 90% target. This suggests a need for further analysis and targeted intervention.
- **Learning trajectory:** The observed slowing growth rate is consistent with the transition from rapid acquisition to mastery and consolidation of knowledge.

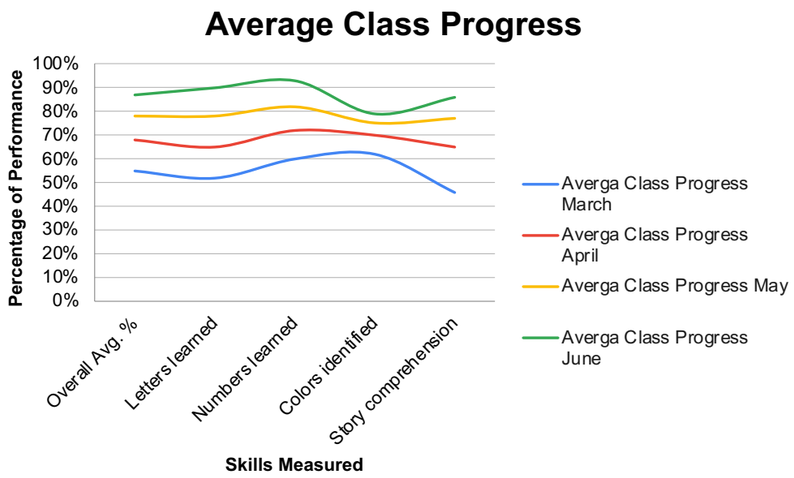


Figure 5. Data Showing Average Class Progress from March-June

4.2 Qualitative Analysis

Thematic coding of qualitative data revealed four major themes:

- **Technology as a Bridge** – highlighting the role of assistive tools in enabling access and participation.
- **Empowering the Role of the Teacher** – emphasizing how the intervention enhanced teacher capacity and instructional practices.
- **Socio-Emotional Well-Being** – reflecting improvements in student confidence, communication, and emotional growth.
- **Inclusive Learning** – demonstrating the creation of more equitable and supportive classroom environments.

Theme	Definition	Supporting Evidence
Technology as a Bridge	Assistive technology enabled smoother learning and established meaningful interactions between students who once limited their circle and interactions only to their teachers, parents/caregivers, and therapists.	Teacher feedback, device usage logs, Classroom Interactions of the Students, and Parental Feedback.
Socio Emotional Well Being	Students were more intrinsically motivated to join the classrooms because they got the opportunity to engage in a circle with their peers, which was previously limited only to their Parents/Caregivers, Siblings, Special Educators, Teachers, and Therapists	Observed through the expression of daily socio-emotional well-being through mood boards.
Empowering the role of the Teacher	Training impact on the facilitators and watching their much-needed transition from traditional teaching methods to digital methods, bridging the technological gap for students with disabilities.	Teacher reflections and post-training notes.
Inclusive Learning	Social and academic participation gains, along with ongoing pre-employability and employability training for students with diverse needs.	Classroom Observation Notes and Class Interactions

Table 1. Summary of Themes and Supporting Evidence

5. Discussion

The Literacy Lab demonstrates how assistive technology, when paired with community engagement and inclusive pedagogy, can revolutionize learning for students with disabilities. Improvements in attendance and academic scores illustrate how meaningful content delivery, when combined with family support and emotional engagement, creates a measurable impact. Self-advocacy practices such as voice recordings empowered students to own their learning, while peer tutoring fostered mutual respect and cooperation.

This case study reinforces the importance of co-designing educational interventions that respect local cultural values, involve families, and adapt technology for real-life classroom applications. It also illustrates the practicality of inclusion: children with disabilities not only learn better but thrive when given accessible tools and empathetic environments.

Quotes from parents, students, or teachers:

1. **"We cannot express how grateful we are for what the Literacy Lab and the Key-X device have brought into Mohamed's life. For months, we watched him try so hard to communicate and learn like other children. This week, when he received his own Key-X, it felt like a dream come true—not just for him, but for us as a family. We have seen him practicing every day at home, getting more confident with each step. When the company gifted him the device, I could not hold back my tears. It was the first time we truly felt seen, supported, and hopeful for his future. This is more than technology, it is a bridge to dignity, inclusion, and opportunity. I hope every parent gets to witness their child feeling this proud and empowered one day."**

— Mohamed's Mother

Figure 6. Mohamed and His Mother receiving his own Key-X

2. **"Over the past four months, I have witnessed incredible growth in our students—academically, socially, and emotionally. The Literacy Lab has created an environment where every child feels seen, supported, and capable. Tools like Key-X and Expressia have given our students the ability to communicate, participate, and most importantly, believe in themselves. Students who once struggled to engage are now raising their hands, helping their peers, and celebrating their progress with pride. The difference is not just in their scores, it is in their smiles, their confidence, and the way they walk into class every day with excitement. As a teacher, I've never been more certain that inclusive education, when done with the right tools and heart, can truly transform lives."**

— Amna Dhafer Rasheid Al Ketbi, Special Educator- Zayed Higher Organization.

Figure 7 & 8. The First Literacy Lab at Zayed Higher Organization, Al Mafraq, Abu Dhabi, UAE

5.1 Limitations and Future Work

While this case study provides valuable insights into the impact of Key2enable's Literacy Lab over four months, there are certain limitations that should be acknowledged. The sample size of fifty students, though sufficient for preliminary analysis, limits the generalizability of the findings across diverse educational contexts and disability profiles. Additionally, the relatively short duration of the study constrains the ability to assess long-term outcomes such as sustained academic achievement, social integration, and post-educational independence.

Furthermore, this study focused primarily on quantitative attendance and academic assessments, complemented by qualitative observations; however, more in-depth longitudinal tracking and controlled comparative studies could provide stronger evidence of causality and scalability.

Recognizing these limitations, Key2enable is actively engaged in expanding the scope and reach of the Literacy Lab model. We are currently in discussions to establish additional Literacy Labs in Abu Dhabi, aiming to increase our sample size and diversify student profiles. We have successfully launched a fully operational Literacy Lab in Dubai, further extending access within the UAE.

Beyond national borders, our vision for inclusive education is gaining momentum internationally. We have expanded our Literacy Lab initiatives to Spain, where plans are underway to open multiple Labs that adapt the model to European educational settings. Recently, we also initiated the rollout of the Literacy Lab in India, a critical step toward reaching underserved populations in a vastly diverse learning landscape.

These expansions will provide richer data and more comprehensive evidence to refine the Literacy Lab's methodologies, technologies, and community engagement strategies. Our future work will focus on longitudinal impact assessments, integration of emerging assistive technologies, and collaboration with local governments and educational institutions to ensure cultural relevance and sustainability.

Through continuous innovation and strategic partnerships, Key2enable aims to contribute robustly to the global movement toward inclusive, accessible, and empowering education for all learners.

Figure 9 & 10. Key2enable's first Literacy Lab with Evoluer Solutions in New Delhi, India

5.2 Policy Implications and Recommendations

The outcome of this case study underscores the urgent need for strategic policy interventions and dedicated funding mechanisms to support inclusive education through assistive technology across the MENA region. As governments increasingly prioritize knowledge economies and equity in education, targeted investments in inclusive ed-tech solutions are not only timely but essential.

- Establish Dedicated Inclusive Ed-Tech Funds: Governments and regional development agencies should create specialized funding streams to support the research, implementation, and scaling of assistive technology in special education settings. These funds should prioritize innovations that promote Universal Design for Learning (UDL), augmentative and alternative communication (AAC), and locally adapted solutions.
- Embed AT Procurement into Public Education Budgets: Assistive technology must be treated as a core educational tool—not as an add-on. Ministries of Education should integrate AT procurement into annual school budgets, ensuring that every student with a disability has access to the tools necessary for meaningful participation.
- Incentivize Public–Private Partnerships (PPPs): Models like Key2enable's Literacy Lab demonstrate the value of collaboration between educational institutions, government bodies, and innovation-driven organizations. Policymakers should offer incentives for such partnerships through grants, tax breaks, or co-investment schemes that foster scalable, region-specific solutions.

- Mandate Inclusive Design in National Curricula and Ed-Tech Initiatives: Inclusive education must be embedded within national learning platforms and digital strategies. Regional ed-tech frameworks should require all new platforms, content, and devices to follow accessibility standards, ensuring that no learner is excluded by design.
- Support Capacity Building and Teacher Training: For assistive technology to be effectively used, educators must be trained in both the pedagogical and technical aspects of inclusion. Funding should be allocated to professional development programs that build inclusive teaching competencies and familiarity with AT tools such as Key-X and Expressia.
- Promote Evidence-Based Pilot Programs with National Rollout Potential: Governments should invest in pilot programs that are research-backed and impact-oriented, such as the Literacy Lab, with a view to scaling them based on data. These initiatives should include robust monitoring and evaluation frameworks to guide policy refinement and nationwide implementation.
- Regional Collaboration and Knowledge Exchange: The successes of the Literacy Labs in the UAE, and their expansion to Spain and India, demonstrate the power of cross-border learning. Policymakers in Doha, Riyadh, Amman, and other cities should engage in collaborative platforms to exchange data, strategies, and technology blueprints for inclusive education.

6. Conclusion

This case study reinforces that inclusive education is not a fixed destination, but a dynamic cycle of growth, adaptation, and empowerment. Over four months, the Literacy Lab has proven its ability to translate assistive technology into measurable progress—elevating students' academic performance, emotional well-being, and self-expression.

The Lab creates a learning environment that is flexible, dignified, and deeply human by placing tools like Key-X and Expressia at the heart of instruction, and by fostering deep collaboration between educators, families, and students. It responds to each learner's individuality while promoting shared success.

More than a program, the Literacy Lab is a living model of inclusion in motion—where research meets community, where policy becomes practice, and where possibility becomes progress. It stands as an example of how thoughtful design and inclusive technology can reshape education not just for some, but for all.

References

1. Alnahdi, G. (2014). Assistive technology in special education and the universal design for learning. Turkish Online Journal of Educational Technology-TOJET, 13(2), 18–23.
2. Beukelman, D., & Light, J. (2020). Augmentative and alternative communication: Supporting children and adults with complex communication needs.
3. CAST. (2018). Universal Design for Learning Guidelines. http://www.cast.org/udl
4. Jigyel, K., Miller, J. A., Mavropoulou, S., & Berman, J. (2018). Parental communication and collaboration in schools with special educational needs (SEN) programmes in Bhutan. International Journal of Inclusive Education, 22(12), 1288–1305.
5. Makoelle, T. (2016). Peer tutoring as a mentoring tool for inclusive learning. In M. van der Merwe (Ed.), Inclusive Teaching in South Africa (1st ed., pp. 79–88). African Sun Media; JSTOR. https://doi.org/10.2307/j.ctv1nzfxs4.14
6. Rahmatullah, I. (2024). Application of Gamification-Based Multisensory Methods in Improving the Brain Ability of Children with Intellectual Disabilities in Learning English Vocabulary. East Asian Journal of Multidisciplinary Research, 3(9), 4065–4084. https://doi.org/10.55927/eajmr.v3i9.10767
7. Schaefer, J. M., & Andzik, N. R. (2016). Switch on the learning: Teaching students with significant disabilities to use switches. Teaching Exceptional Children, 48(4), 204–212.
8. Troshina, E. P., Baraboshkina, E. A., & Mantulenko, V. V. (2021). USING DIGITAL TECHNOLOGIES IN INCLUSIVE EDUCATION. Science and School, 133–142. https://doi.org/10.31862/1819-463X-2021-1-133-142
9. United Nations Educational, Scientific and Cultural Organization (UNESCO). (2023). Securing the universal right to education in the Arab States through INCLUSIVE, EQUITABLE, SAFE, AND HEALTHY SCHOOLS. https://www.unesco.org/sites/default/files/medias/fic

المراجع

1. Alnahdi, G. (2014). Assistive technology in special education and the universal design for learning. Turkish Online Journal of Educational Technology-TOJET, 13(2), 18–23.
2. Beukelman, D., & Light, J. (2020). Augmentative and alternative communication: Supporting children and adults with complex communication needs.
3. CAST. (2018). Universal Design for Learning Guidelines. http://www.cast.org/udl
4. Jigyel, K., Miller, J. A., Mavropoulou, S., & Berman, J. (2018). Parental communication and collaboration in schools with special educational needs (SEN) programmes in Bhutan. International Journal of Inclusive Education, 22(12), 1288–1305.
5. Makoelle, T. (2016). Peer tutoring as a mentoring tool for inclusive learning. In M. van der Merwe (Ed.), Inclusive Teaching in South Africa (1st ed., pp. 79–88). African Sun Media; JSTOR. https://doi.org/10.2307/j.ctv1nzfxs4.14
6. Rahmatullah, I. (2024). Application of Gamification-Based Multisensory Methods in Improving the Brain Ability of Children with Intellectual Disabilities in Learning English Vocabulary. East Asian Journal of Multidisciplinary Research, 3(9), 4065–4084. https://doi.org/10.55927/eajmr.v3i9.10767
7. Schaefer, J. M., & Andzik, N. R. (2016). Switch on the learning: Teaching students with significant disabilities to use switches. Teaching Exceptional Children, 48(4), 204–212.
8. Troshina, E. P., Baraboshkina, E. A., & Mantulenko, V. V. (2021). USING DIGITAL TECHNOLOGIES IN INCLUSIVE EDUCATION. Science and School, 133–142. https://doi.org/10.31862/1819-463X-2021-1-133-142
9. United Nations Educational, Scientific and Cultural Organization (UNESCO). (2023). Securing the universal right to education in the Arab States through INCLUSIVE, EQUITABLE, SAFE, AND HEALTHY SCHOOLS. https://www.unesco.org/sites/default/files/medias/fic