Montessori Design Connect: Interactive Learning for Autistic Children with the Innovation of EPUB Design QR Integration

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ABSTRACT

This innovative product integrates a Montessoriinspired physical book with a QR-linked digital EPUB to support children with autism spectrum disorder (ASD) through multisensory and interactive design learning. The physical book includes hands-on activities such as tracing, matching, and flip-and-reveal pages that foster fine motor skills, sensory engagement, and early learning. The digital design EPUB, accessed via a QR code, enhances the experience with educational materials, vivid visuals, short videos, and simple explanations of autism-related topics like brain development, stimming, communication differences, and sensory sensitivity designed to be understood by both children and adults. The idea was inspired by the increasing demand for inclusive and accessible educational tools. It combines the Montessori method, which emphasizes independent and practical learning, with digital technology to meet the structured and visual preferences of many autistic children. The book uses calming patterns and sensory friendly materials to reduce overstimulation while promoting engagement. This innovation brings meaningful educational benefits by supporting inclusive classrooms and helping children develop cognitive, emotional, and motor skills. It strengthens parent-child and teacher-student interactions by offering accessible, user-friendly resources. The digital content allows for repeated learning, which is particularly helpful for children who thrive on routine and visual reinforcement. From a commercial perspective, the product is cost-efficient and highly adaptable for different environments including homes, schools, therapy centres, and learning kits. With rising global awareness of autism and inclusive education, it has strong market appeal and profitability. It can be marketed through therapy programs, online platforms, bookstores, and educational distributors, offering significant growth opportunities locally and internationally.

Keywords: Interactive digital EPUB design technology; autism spectrum disorder (ASD); Montessori-inspired learning; Multisensory engagement; Hands-on activities

INTRODUCTION

The complex neurodevelopmental disorder known as autism spectrum disorder (ASD) is typified by limited, repetitive patterns of behaviour, interests, or activities as well as ongoing difficulties with social communication and interaction (American Psychiatric Association, 2013). The diagnosis of ASD necessitates proof of symptoms in early developmental stages that result in clinically significant impairment in social, occupational, or other critical areas of functioning, as per the Diagnostic and Statistical Manual of Mental Disorders (DSM5). The following are the main diagnostic criteria:

- **Deficits in social-emotional reciprocity** such as difficulty with normal back-and-forth conversation or reduced sharing of emotions
- **Deficits in nonverbal communicative behaviors** including abnormal eye contact and difficulties understanding gestures;
- **Deficits in developing, maintaining and understanding relationships**

- **Restricted, repetitive patterns of behavior** such as stereotyped movements, insistence on sameness, highly restricted interests, and sensory hyper or hypo reactivity (American Psychiatric Association, 2013).

The prevalence of ASD has been increasing globally. As a result of better screening and greater awareness, the U.S. Centres for Disease Control and Prevention (CDC) projected that 1 in 36 children had an ASD diagnosis in 2020 (Maenner et al., 2023). Due to a lack of national surveillance, estimates in Malaysia vary, but recent studies indicate that rates as high as 1 in 625 children may be impacted (Ismail & Jaafar, 2018). These figures are probably underreported because of stigma and difficulties with diagnosis (Kaur et al., 2019). This emphasises how urgently accessible, culturally aware interventions that are adapted to the Malaysian educational environment are needed.

According to Montessori (1912) and Schaaf et al. (2014), traditional classroom practices often focus on strict and consistent teaching approaches. These methods may not effectively accommodate the sensory sensitivities, various learning styles, and need for predictability that many autistic learners need in order to achieve optimal results. For instance, children who have autism spectrum disorder (ASD) typically exhibit difficulty in sensory processing. These impairments might include sensitivity to sound, touch, or visual stimuli, which can result in overstimulation in traditional learning contexts (Schaaf et al., 2014).

Among the many approaches, the Montessori technique is one that is very compatible with the specific educational requirements of autistic children. According to (LaneBarmapov,2016) and (Montessori,1912), this educational concept places an emphasis on learning that is self-directed and multisensory via the use of organised hands-on activities. Montessori-inspired techniques empower children to learn at their own speed while simultaneously developing independence and engagement via the use of tactile materials and visual aids. These practices are aligned with evidence based autism therapies (Lovaas, 1987) and (Schaaf et al., 2014).

The possibilities for inclusive education have been revolutionized as a result of technology improvements, which have occurred concurrently with the increased interest in Montessori techniques themselves. According to (Ayres,2005) and (Lee and McKee,2023), interactive EPUBs and digital material provide customizable sensory aspects, predictable encouragement, and interactive media explanations. These qualities allow for repeated exposure and promote understanding. Recent research has shown that the use of digital technologies combined with organised visual approaches may enhance the level of motivation, decrease fear, and boost involvement among autistic learners (Vatanparast, 2023).

The objective of the project titled "Montessori Design Connect: Interactive Learning for Autistic Children with the Innovation of EPUB Design-QR Integration" is to combine the efficiency that has been shown in Montessori-inspired educational materials with an interactive EPUB that is connected to QR codes. The purpose of this hybrid innovation is to provide autistic children with a learning environment that is low anxiety and engaging, while also catering to their specific cognitive, sensory, and emotional requirements. Not only does the EPUB cater to the learning needs of the children, but it also offers several helpful materials for the parents and caretakers of the child. This design serves a dual function, supplying both interactive information for children and support resources for caretakers. It provides a full learning experience that covers the expectations of both children and adults. QR codes are strategically positioned in front of the book to accomplish this dual purpose.

The following objectives acted as a guide for the purpose of this study.

- To create and build Montessori create Connect, an educational product that encourages children with autism spectrum disorder to engage in blended learning by combining a physical book that is inspired by Montessori with an EPUB that is connected to a QR code.
- To provide an explanation of the instructional design process as well as the distinctive characteristics of the invention.
- To investigate the possibility that it could improve engagement, sensory regulation, and cognitive development in educational environments that are inclusive.

This paper outlines the reasons behind, the design process of, and the possible educational impacts of Montessori Design Connect. This project combines traditional Montessori educational approaches with digital technology, helping to improve inclusive education for children with autism in Malaysia and around the world.

LITERATURE REVIEW

Autism Spectrum Disorder and Educational Challenges

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterised by ongoing challenges in social communication, limited interests, and variations in sensory processing (American Psychiatric Association, 2013). These traits can lead to major difficulties in regular classrooms, where kids with ASD might face sensory overload, struggle with understanding verbal directions, and encounter obstacles in social interaction (Schaaf et al., 2014). Studies indicate that sensory sensitivities, like being overly sensitive to sounds, touch, or visual inputs, can result in anxiety and a lack of engagement (Ayres, 2005). In Malaysia, the challenges are made more severe by limited resources and a lack of specialised support, which often leads to unmet educational needs (Kaur et al., 2019). This evidence highlights how crucial it is to create learning materials that minimise sensory overload and offer structured, predictable experiences, which played a key role in shaping the Montessori Design Connect innovation.

Montessori Method in Special Education

The Montessori method, created by Maria Montessori in the early 20th century, focusses on independent thinking and multisensory learning through structured hands-on activities (Montessori, 1912). Montessori classrooms are set up to help kids become more independent, focus better, and feel motivated from within. They do this by offering materials that engage different senses and let children learn at their own speed (Lillard, 2005). Montessori principles can provide children with ASD predictable routines and calming sensory input, which helps reduce anxiety and improve engagement (LaneBarmapov, 2016). Research has shown that Montessoriinspired methods can positively influence children's cognitive, motor, and social development (Lillard, 2005). Even though there are these advantages, Montessori tools aren't really used much with today's digital technologies in inclusive classrooms. So these principles has inspired the physical design elements of Montessori Design Connect, such as tracing, matching, and flip-and-reveal activities that support tactile learning and independent exploration.

Digital Learning Technologies for Children with Autism

Integration of digital tools like interactive eBooks, mobile apps, and multimedia platforms are becoming more common in special education (Lee & McKee, 2023). Digital resources provide autistic learners with reliable visual cues, opportunities for repetitive practice, and accessible features that cater to their unique sensory needs (Ayres, 2005). According to research by Vatanparast (2023), using interactive digital content can boost motivation and help improve social skills training for children with ASD. Also, research indicates that using visuals, audio narration, and animations together helps with understanding and keeping people interested (Lee & McKee, 2023). Even with these benefits, a lot of digital tools aren't made with Montessori principles in mind or don't work well with physical learning materials. These findings guided the inclusion of an EPUB component in Montessori Design Connect, providing multimedia explanations and interactive content accessible through QR codes to enhance motivation and understanding.

METHODOLOGY

This study adopted a developmental research design to guide the creation and evaluation of an innovative educational product for children with autism spectrum disorder. The research process was carried out in five structured phases: (1) needs analysis to identify learning challenges and gaps in existing resources, (2) validation of the planned content and materials by field experts, (3) design and development of the Montessori Design Connect product, (4) implementation through pilot use in a small group setting, and (5) evaluation of usability, engagement, and sensory response. Each phase was conducted systematically to ensure that the final product met the unique cognitive, sensory, and motivational needs of autistic learners while promoting multisensory engagement and independent exploration.

Needs Analysis

A needs analysis was carried out to find out the specific challenges that children with ASD face in learning environments and to pinpoint gaps in the educational materials that are currently available. A review of relevant literature showed that many autistic learners encounter challenges due to processing verbal instructions (Ayres, 2005) and (Schaaf et al., 2014). Casual chats with a few of special education teachers in Malaysia showed that even though Montessori materials really got students interested, they usually didn't have multimedia supports to help reinforce concepts visually and auditorily. Also, the current digital learning resources seemed to be either too overwhelming or not really suited to the local circumstances. This analysis showed that we really need a mix of hands-on activities and easy-to-access digital content to boost engagement and understanding.

Learning

Multisensory learning strategies mix hands-on, visual, and listening techniques to improve understanding and help remember information better (Schaaf et al., 2014). Multisensory environments can really help children with autism by regulating sensory input, encouraging them to participate more actively, and supporting their language development (Ayres, 2005). Research has shown that touchscreen mobile devices are effective in supporting engagement, communication, and skill-building for individuals with developmental disabilities, including those with autism (Stephenson & Limbrick, 2015) and hybrid approaches that combine physical materials with digital content such as augmented reality books or QR-linked resources, are being acknowledged more and more for their ability to enhance accessibility and engagement in learning (Vatanparast, 2023).This research laid the groundwork for creating Montessori Design Connect, which combines printed Montessori-inspired book with interactive digital learning experiences.

Research Gap

Previous studies have shown the benefits of Montessori methods and digital tools on their own, but there isn't much research that combines these approaches into a single, multisensory educational product for children with autism. So far, there haven't been any studies in Malaysia that have created a hybrid innovation combining Montessori-inspired hands-on activities with an interactive EPUB that can be accessed through a QR code.This gap directly influenced the goal of this study, which is to develop, describe, and evaluate Montessori Design Connect as a new and innovative hybrid learning resource that meets these unmet needs.

Validation of Instruments

Two special education teachers with experience in autism interventions reviewed the preliminary design, learning objectives, and content structure of the Montessori Design Connect innovation. The validation looked at whether the activities were suitable, how clear the instructional content was, and the multimedia elements suggested. The feedback highlighted how crucial it is to keep a consistent visual style in both printed and digital materials. The EPUB interface was improved by using neutral colour schemes, clear icons, and calm narration based on this input. The layout of the physical book was changed to make the visual presentation easier to understand and to ensure there is enough space for tracing activities.

Design and Development

Montessori Design Connect is an educational tool that combines a physical activity book inspired by Montessori with interactive EPUB content that you can access using a QR code. The design process had multiple stages to make sure the final product was accessible, engaging, and suitable for kids with Autism Spectrum Disorder.

Integration of EPUB Design with QR Code Technology

One important aspect of Montessori Design Connect is how it combines a printed activity book with digital content that you can access using just one QR code. The QR code is placed clearly on the front cover to make it easy to scan and to reduce distractions during hands-on activities.

The EPUB was created with Adobe InDesign and includes multimedia features like narrated videos, easing animations, and easy-to-read text following design best practices outlined by Bozkurt and Bozkaya (2015). This resource includes 15 pages of organised content aimed at supporting the printed activities and offering easy-to-understand information on topics related to autism, like stimming, sensory sensitivity, and communication differences. Every EPUB page blends images and sound to provide a consistent, multisensory experience that matches the needs of autistic learners who prefer routine and clear visual signals. The EPUB has resources and tips that can help caretakers and educators support learning.

The EPUB file is hosted on a secure digital platform that you can access using Android and iOS devices. The QR code, when scanned, takes you to the EPUB, which you can open using regular EPUB reader apps. This method brings together the advantages of hands-on activities and engaging digital support, resulting in a smooth hybrid learning experience.

Fig. 1 - Example Of 15 Pages Interactive Digital EPUB Content

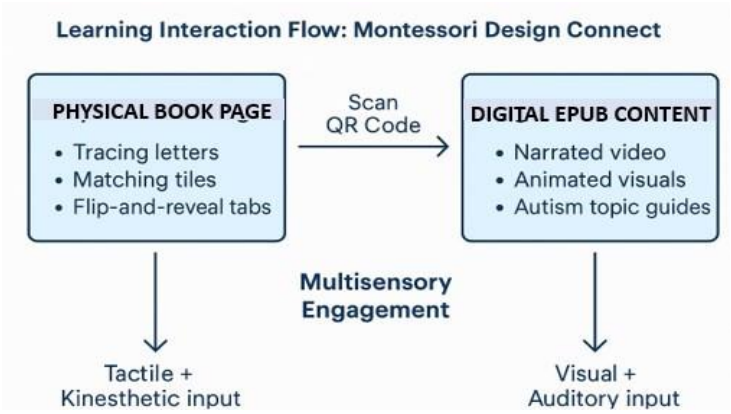

Fig. 2- Learning Interactive Flow of Montessori Design Connect & QR Integration EPUB Ebook

Production and Material Selection

Physical materials were chosen to promote safe handling and sensory regulation. The activity book was made with soft matte laminated card stock which helps to minimise glare and feels nice to touch. Interactive components feature Velcro patches, flip-and-flap tabs, removable pieces, and textured tracing lines that promote fine motor skills and visual exploration. We tested all the materials to see how durable they are and how easy they are for young kids to use, making sure they can handle being used over and over again in classrooms or at home.

Fig. 3 - Montessori Design Connect printed activity book displaying the learning content.

QR Code Integration

The QR code that connects the printed and digital resources s located on the front cover, making it easy to access. This design choice lets children or parents scan the code at a start of an encounter and then move on to hands on or multimedia activities when needed.

Fig.4 QR code displayed on the front cover of the printed activity book

Usability Testing and Iteration

Three children with ASD, their parents, and two special education instructors took part in a pilot test. We looked at how interested individuals were, how simple it was for them to transition between print and digital content, and how they felt about the sensory sensations. Feedback said that the narrative could go slower, the symbols in

the EPUB interface should be easier to understand, and the visual aspects should have greater contrast. The final version incorporates these adjustments to make it more accessible and pleasant.

Software and Tools

The development process utilized the following tools and materials:

Design Software: Adobe InDesign (for EPUB production) and Adobe Illustrator (for graphics and layout)

Device Testing: Android and iOS smartphones and tablets for QR scanning and EPUB display

Physical Materials: Textured card stock, Velcro, nontoxic adhesive, and matte lamination for the activity book components

Implementation

The invention was tried with three youngsters aged 6–8 diagnosed with ASD. Each participant participated in guided sessions utilising the printed book and EPUB throughout four sessions. A instructor presented each activity, showed QR code scanning, and evaluated reactions to multimodal materials. Implementation focused on assessing engagement, simplicity of use, and independence.

Evaluation

Evaluation was conducted to determine how effectively the Montessori Design Connect tool engaged learners with autism spectrum disorder (ASD), supported their independence, and managed sensory responses. The assessment was carried out using a combination of facilitator observation checklists and anecdotal records.

Participants and Sessions

The pilot implementation involved three children aged 6–8 diagnosed with ASD, along with their parents and two special education teachers. Each child participated in four guided sessions (about 20–30 minutes each) over two weeks. Sessions were conducted in a familiar learning environment (home and therapy setting) to ensure comfort and minimize external distractions.

Evaluation Criteria

Facilitators observed and recorded responses across the following areas:

Engagement: Frequency and duration of active participation

Ease of Navigation: Ability to switch between printed and digital content

Sensory Response: Reactions to tactile materials, visual elements, and audio

Independence: Level of assistance needed to complete tasks

Key Findings

Engagement: All participants showed increased attention and interest during tactile tracing and flip-tab activities. Two children expressed a preference for repeating the same EPUB video, indicating comfort in routine-based learning.

Navigation: Children were able to scan QR codes with minimal help after the first session. Transitioning from print to digital activities was smooth when guided by a caregiver.

Sensory Response: No signs of overstimulation were observed. One child verbally noted that the visuals were "calm" and liked the "soft voice" in the narration. • **Independence**: One participant completed tracing and matching activities without assistance by the third session. Others needed minor verbal prompts or gestures.

Parental and Teacher Feedback

Feedback from parents and educators was generally positive:

“It’s easier to explain the concepts with both the book and the videos.”

“My son was more focused than usual. He liked scanning the code and watching the video after doing the tracing.”

“Simple layout and visual repetition helped them stay calm.”

Evaluation Criteria	Observation Summary	Notes
Engagement	All 3 children showed interest during tracing and flip-tab activities	Repetition was preferred
Ease of Navigation	QR code scanning was successful by Session 2	Caregiver assistance reduced
Sensory Response	No overstimulation observed	Calm visuals and narration were effective
Independence	1 child worked independently by Session 3	Others required minor prompts

Figure 5 - Summary of pilot evaluation findings based on engagement, navigation, sensory response, and independence.

Based on this feedback, minor improvements were implemented in the EPUB interface, such as increasing visual contrast and slowing down some animations. Symbols were redesigned to be more intuitive for early readers.

DISCUSSION

The first findings from Montessori Design Connect show that it might help children with Autism Spectrum Disorder (ASD) learn better, be more independent and feel more comfortable with their senses. By using both Montessori-style physical exercises and digital EPUB content children could work with elements they had previously become familiar with and that weren't too stressful while also getting audio-visual support. These results are in line with studies by Schaaf et al. (2014) and Vatanparast (2023) which showed that multisensory and routine-based tools may help neurodiverse learners concentrate better and feel less anxious.While a recent systematic review by Valencia et al. (2019) also confirms that digital tools, when designed with attention to sensory needs and interactivity, can significantly support cognitive, social, and emotional development in individuals with ASD.

Parents and teachers said that the structured presentation, repeated pictures, and QR-linked digital access made it simpler to keep kids' attention. This backs up what Lee and McKee (2023) found before, which was that hybrid materials can help kids with ASD improve their social and communication skills. Carers could choose between physical and digital materials, which offered them more freedom during sessions. This made the product good for both home and school settings.

The textured tracing lines, soft lamination, and flip-tab mechanisms were all examples of physical design choices that added to the visual content by giving it a sense of touch. These are based on Montessori ideas about independence and sensory exploration (Montessori, 1912), but they have been changed to meet the needs of people with ASD, such as needing predictable patterns and calming layouts. The evaluation found that engagement and accessibility had improved, but it also found areas that needed improvement, such as making icons easier to understand and slowing down animations.

The innovation is important because it not only helps learners, but it also serves as a resource for parents and teachers. This fills a gap in Malaysia's accessible, localised tools for ASD. This two-in-one approach sets it apart from many other ASD tools that only help the learner and don't offer support for carers.

The study shows that combining tactile and digital learning can help kids with autism become more independent, motivated, and comfortable, especially in early education settings. To find out how well the tool works in the long term and to make it more widely available, more testing and longer-term studies are needed.

INTERPRETATION OF RESULTS

Limitations

Despite offering insightful information, the pilot study has a number of limitations that should be noted. First off, there were only three children with autism spectrum disorder (ASD) in the small sample size. This limits the findings' applicability to the larger ASD population.

Second, the short duration of the testing sessions may not capture long-term engagement or developmental impact. Ongoing use in classroom settings is required to better understand how the tool supports learning over time.

Finally, informal interviews and observations were the main methods used to collect feedback. Despite being educational, these approaches might be constrained by the kids' communication skills or impacted by facilitator prejudice. To improve data reliability, future research could use quantitative tracking or structured assessment instruments.

Implications for Broader Educational Contexts

This project has several implications for wider educational practice:

Adaptability to Inclusive Classrooms:

Montessori Design Connect can be used in classrooms that include all kinds of learners, helping kids with different needs, like those with ASD, developmental delays, and attention challenges.

Support for Home-Based and Early Intervention Learning:

The hybrid format that mixes print and digital content works well for home use and early intervention programs, giving families and therapists organised and reliable learning resources.

Contribution to Best Practices in Inclusive Education:

This innovation shows how Montessori principles can be combined with EPUB technology to encourage multisensory engagement and independent exploration.

Potential for Future Development and Scaling:

Future study might look at customizing content, broadening distribution to interact with more individuals, and examining long-term learning effects to increase the evidence for hybrid educational goods.

Accessibility Challenges

A number of accessibility issues were found, despite the fact that the Montessori Design Connect tool is made to be flexible in home, school, and therapy settings.

First, access to digital devices is still an issue for rural communities or lower-income families who might not have smartphones or tablets that can run EPUB readers. This restricts the digital component's reach. Future versions might include printable multimedia QR guides or offline-accessible EPUB versions to address this.

Second, possible overstimulation from digital content was taken into account, including screen brightness, motion graphics, and sound effects. The design made use of low contrast animation, slow-paced narration, and gentle visuals to reduce sensory overload. However, to accommodate different sensory sensitivity, customisation settings are required (e.g., turning off sound or adjusting visual intensity).

Third, in order to effectively use the digital and physical resources, carer or educator training might be necessary.

Concerns regarding the transition between book and EPUB activities were voiced by a few parents. To guarantee seamless implementation and lessen reliance on facilitation, basic user manuals or instructional videos should be produced.

These challenges highlight the importance of inclusive design not just in content but also in delivery and accessibility infrastructure, especially in the Malaysian context. This aligns with the principles of Universal Design for Learning (UDL), which promote flexibility, accessibility, and learner engagement across diverse needs (Al-Azawei, Serenelli, & Lundqvist, 2016).

Scalability and Customization Roadmap

Future development should concentrate on scalability and customisation in order to optimise the impact of Montessori Design Connect across a variety of learning environments. The idea can be modified for a broader age range through theme variations, differentiated difficulty levels, and language support, although the current format is best suited for kids ages 6 to 8.

Modules covering social skills, daily routines, and expressive communication that are geared towards younger learners (ages 5–7) or older kids (ages 8–12) can be added to the EPUB content. It is possible to incorporate themes like nature, transportation, or animals to match classroom subjects and student interests.

Furthermore, localisation features that support broader adoption in Malaysian and regional contexts include bilingual content (e.g., Malay and English), culturally familiar imagery, and carer guidance in Bahasa Malaysia.

The tool would be even more accessible and useful in group learning environments if it came with a structured implementation kit for teachers that included printable worksheets and usage guides. Given the growing need for inclusive education resources, this hybrid design has a great chance of being replicated and distribute throughout educational institutions, therapy facilities, and online learning environments.

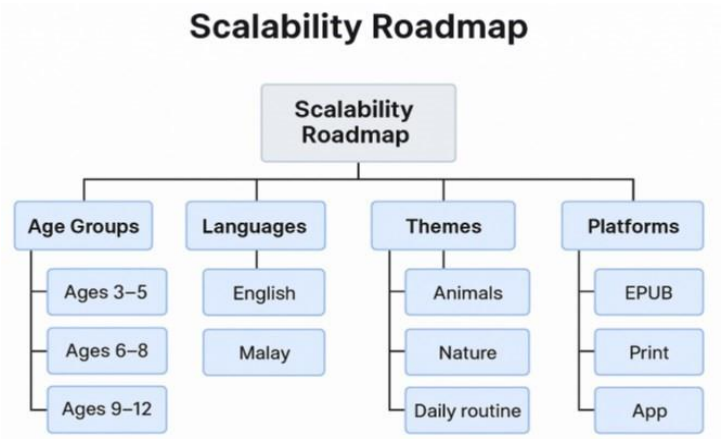

Figure 6 - Scalability roadmap illustrating the future expansion of Montessori

Design Connect by age group, language support, learning themes, and platform delivery options.

CONCLUSIONS

The development of Montessori Design Connect serves as an example of how hybrid learning materials can successfully address the various learning requirements of kids with ASD. This innovation tackles common learning challenges like sensory sensitivity, short attention spans, and trouble understanding abstract instructions all of which have been well-documented in previous research by combining interactive EPUB content with hands-on activities inspired by Montessori education (Ayres, 2005; Schaaf et al., 2014).

Positive engagement, more seamless transitions between print and digital content, and growing learner independence were all observed during the pilot implementation. These results validate previous research showing that blended tools that combine digital and tactile experiences can improve routinebased learning, lower

anxiety, and increase motivation (Vatanparast, 2023; Lovaas, 1987). Additionally, the product's design complies with accepted standards for interactive ebooks and applications for visual-based learning (Parsons et al.,2017).

This project offers a dual-purpose resource for kids and carers, which not only promises usability but also supports inclusive education practices. Its design promotes multisensory engagement while maintaining accessibility in therapeutic, educational, and home settings. With careful design decisions like calming imagery and optional physical usability, issues like digital access and sensory overload were taken into account and resolved.

Montessori Design Connect has a lot of room to grow and be customised in the future. Future developments could include creating mobile or app-based platforms, providing bilingual versions, and extending the content for various age groups. Longitudinal tracking and larger studies will confirm its educational impact.

In the end, this project emphasises how crucial it is to create inclusive tools that are sympathetic, flexible, and jointly developed with feedback from therapists, parents, and educators. Tools such as these can bridge the gap between traditional methods and digital innovation to create more meaningful learning experiences for children with neurodiverse learning styles as inclusive education gains more attention.

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