A Digital Environment for Developing Mathematical Abilities in Children with Autism Spectrum Disorder

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Abstract : Research on academic abilities of individuals with autism spectrum disorder (ASD) underlines the importance of mathematics interventions. Yet the proposal of digital applications for children and youth with ASD continues to attract little attention, namely, regarding the development of mathematical reasoning, being the use of the digital technologies an area of great interest for individuals with this disorder and its use is certainly a facilitative strategy in the development of their mathematical abilities. The use of digital technologies can be an effective way to create innovative learning opportunities to these students and to develop creative, personalized and constructive environments, where they can develop differentiated abilities. The children with ASD often respond well to learning activities involving information presented visually. In this context, we present the digital Learning Environment on Mathematics for Autistic children (LEMA) that was a research project conducive to a PhD in Multimedia in Education and was developed by the Thematic Line Geometrix, located in the Department of Mathematics, in a collaboration effort with DigiMedia Research Center, of the Department of Communication and Art (University of Aveiro, Portugal). LEMA is a digital mathematical learning environment which activities are dynamically adapted to the user's profile, towards the development of mathematical abilities of children aged 6–12 years diagnosed with ASD. LEMA has already been evaluated with end-users (both students and teacher's experts) and based on the analysis of the collected data readjustments were made, enabling the continuous improvement of the prototype, namely considering the integration of universal design for learning (UDL) approaches, which are of most importance in ASD, due to its heterogeneity. The learning strategies incorporated in LEMA are: (i) provide options to custom choice of math activities, according to user's profile; (ii) integrates simple interfaces with few elements, presenting only the features and content needed for the ongoing task; (iii) uses a simple visual and textual language; (iv) uses of different types of feedbacks (auditory, visual, positive/negative reinforcement, hints with helpful instructions including math concept definitions, solved math activities using split and easier tasks and, finally, the use of videos/animations that show a solution to the proposed activity); (v) provides information in multiple representation, such as text, video, audio and image for better content and vocabulary understanding in order to stimulate, motivate and engage users to mathematical learning, also helping users to focus on content; (vi) avoids using elements that distract or interfere with focus and attention; (vii) provides clear instructions and orientation about tasks to ease the user understanding of the content and the content language, in order to stimulate, motivate and engage the user; and (viii) uses buttons, familiarly icons and contrast between font and background. Since these children may experience little sensory tolerance and may have an impaired motor skill, besides the user to have the possibility to interact with LEMA through the mouse (point and click with a single button), the user has the possibility to interact with LEMA through Kinect device (using simple gesture moves).

Keywords : autism spectrum disorder, digital technologies, inclusion, mathematical abilities, mathematical learning activities
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