Challenges with the participatory design of digital assessment of child handwriting skills: Can children be jury and judge?

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Participatory design has played a huge role in Interaction Design for Children, where different approaches have been explored. This is more important than ever in the age of AI since children may access and engage with AI systems from a young age in a variety of contexts. Even though the creation of digital assessment and diagnostic tools for children is one of the most researched uses of AI, this application domain primarily included professionals throughout the design, and evaluations are primarily technical, thus, it is unclear how children could be involved within the design of digital assessment tools. In this position paper, we discuss some challenges involving children in designing and evaluating a smart pen to assess their handwriting skills. We proposed that children can be jury and judge in the early stages of the design of tools that are ethical, fair, and safe.

CCS CONCEPTS • Human computer interaction (HCI) -> Interactive systems and tools

Additional Keywords and Phrases: Participatory design, AI, HCI, children, design

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1 INTRODUCTION

Participatory design has played a huge role in Interaction Design for Children, where many different activities and approaches have been explored [1]. This is becoming more crucial in the AI era, where from an early age, children have access to and interact with AI systems in different settings, for example, when they ask requests from Alexa or Siri, or when watching automatically suggested videos. Beyond using those in everyday life, one of the most explored uses of AI for children is the development of digital assessment and diagnostic tools [2]. For example, when developing technology to assess handwriting skills in children, most of the research has focused on evaluating the accuracy of Machine Learning models to predict whether children have dysgraphia or not with data collected using tablets or smart devices [3]. Thus, most children only participate during the evaluation by conducting a traditional assessment using technology. Therefore, their feedback and experience are not considered. These types of applications mainly involve professionals (clinicians or therapists) during the design, and evaluations are mostly technical, using data collected from children [2]. To our knowledge, it is unclear how children could be involved in the design of digital assessment tools.

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In this position paper, we discuss a set of challenges involving children in the design, development, and evaluation of a smart pen to assess their handwriting skills. We proposed that children can be jury and judge in the early stages of the design and be involved in user studies after technical evaluations are done to develop AI digital assessment tools that are ethical, fair, and safe. This workshop represents an opportunity to first present our case study and experiences, then discuss how children could be involved early in the design.

2 THE CASE OF ASSESSING HANDWRITING SKILLS USING PENSANDO

Children face challenges hampering their social inclusion at school, where handwriting is key [4]. Research and industry have shown that it is feasible to use technology to support handwriting and as an alternative for writing, as with touch screens, smart pens, and speech-to-text tools. Also, it shows that it is possible to identify writing patterns and recognize paper-based writing [5], which is evidence of the potential of using smartpens. To our knowledge, these have yet to be designed and used to assess children's handwriting skills. To address this gap, we created PenSando (Figure 1), a smartpen augmented with sensing capabilities to automatically detect a child's handwriting ability [6]. Teachers, designers, and psychologists who specialized in children's fine motor skills participated in the design of PenSando. The contribution of the participatory design allowed us to decide the pen's form factor, size and features to measure speed, legibility, and strength. The pen senses inertial and pressure measurement. It provides a 3D-printed case to ensure a proper and safe grip. We ran a pilot study with two children to understand their experience while writing using PenSando; results showed that children could write using PenSando. They found it easy to use but requested more feedback about their writing.

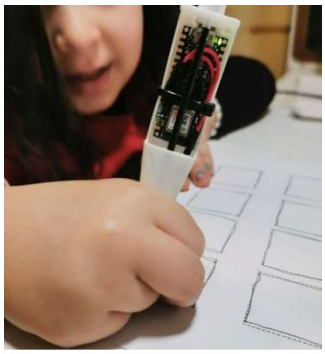

Figure 1: A child participating in the pilot evaluation of PenSando.

3 CHALLENGES TO IMPROVE PENSANDO

Participatory design involving children is challenging. Still, it is even more difficult when the design is something that will evaluate children's behaviors and skills. There is a trade-off between the engaging experience of children using PenSando and collecting data in an appropriate way (e.g., data collected, experiment setup, and conduction) for the specialist to conduct the assessment.

After the pilot study with PenSando when children and experts were involved (unfortunately, at this stage, we were not able to include children in the design given the COVID-19 restriction), we found interesting feedback that led us to think about PenSando's design and data visualization. We found the following concerns when deploying an AI tool like PenSando.

Tradeoffs between designing engaging activities with children that collect relevant data for AI. Most AI models rely on the quality and quantity of data [7]; therefore, it is crucial to properly collect the data needed. To accomplish this aim, when working with children, it is important to maintain their engagement in the tasks to collect data. Currently, the pilot study involved writing their names, dates, and geometric figures five times as suggested by traditional assessments, so, as expected, children found it tedious. Therefore, data could be biased given the tedious task, but at the same time, not having enough data could bias the AI model. Participatory design should include all stakeholders, in this case, therapists, psychologists, teachers, and children, to balance the children's motivation and the focus of the assessment.

Involved children with diverse skills. Children's writing skills vary, given their age, culture, and neurodiversity, among others [8]. Therefore, all those factors should be considered when designing technology to ensure a fair assessment that includes the characteristics of all children. For example, sensory differences exhibited by autistic children [9] may bias the data collected if children refuse to touch the pen given the textures. As PenSando's main goal is handwriting assessment, there is a need to consider how both the design AI models should be adapted for neurodiverse.

Provide understandable feedback on the collected data to the children. A key challenge when working with children is their engagement; the literature recognizes that providing feedback is a strategy that can help with this and gain other benefits for children [10]. During the pilot evaluation of PenSando with the children, we showed them the interior of PenSando (see Figure 1). We informed them that PenSando has some features that evaluate their handwriting. Therefore, they were curious about the outcome and verbally requested feedback (e.g., lights or vibrations) to see how they were doing and how they could improve. This is also important when developing an AI system, as this could improve transparency and explainability. However, this should be carefully designed with specialists for the children to provide data that is safe, and with and by the children to make sure it is understandable.

4 HOW PENSANDO WILL ADDRESS THOSE CHALLENGES

While researching with PenSando we found that designers must think beyond the assessment's goal, and create a balance, when there is the need to evaluate children between design decisions (judge) and all the stakeholders involved (jury). In future work with PenSando, we propose a twofold assessment, including technical aim-directed and case studies, where all stakeholders are included. The following strategies will be included:

- A team of diverse children ilities, specialists in handwriting and child development, and specialists in AI and child-computer interaction will be involved from the design stage until the evaluation.
- Children will actively participate in the design to "jury" the form factor of the pen, making sure it is feasible and comfortable to write, designing potential engaging activities to avoid tedious repetitions, and ensuring the data visualization is understandable and meaningful.
- At the same time, handwriting and child development specialists will participate in making sure that the proposed activities are appropriate to assess handwriting skills, propose what type of information is relevant to improve and ease current assessment, and what type of information is appropriate for the children to see and encourage them about improving their handwriting skills without harm.
- AI and HCI experts need to make sure that the data collected is appropriate and enough to develop AI models able to predict features that ease the handwriting assessment and make sure that the proposed models fulfill the needs of both children and specialists.

5 CONCLUSION

In this paper, we present the case study of PenSando, a smartpen augmented with sensing capabilities to automatically detect a child's handwriting ability. While we developed the first version of PenSando and ran a pilot study, we found tradeoffs between designing assessments that are engaging by children and collecting relevant data to develop AI models. The AI models should provide children with understandable, transparent, and nto encourage them to practice writing skills. Data collected should be from children with diverse backgrounds and skills. Those challenges will be addressed in the design, development, and evaluation of the second version of PenSando to ensure the needs of children and specialists. AI experts should focus on developing AI digital assessment tools that are ethical, fair, and safe.

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