Developing IDEAS: Supporting children with autism within a participatory design team

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ABSTRACT

IDEAS (Interface Design Experience for the Autistic Spectrum) is a method for involving children with Autism Spectrum Disorders (ASD) in the technology design process. This paper extends the IDEAS method to enable use with a design team, providing specific added support for communication and collaboration difficulties that may arise. A study to trial this extended method was conducted with two design teams, each involving three children with ASD, in a series of six, weekly design sessions focused on designing a math game. The findings from this study reveal that the children were able to successfully participate in the sessions and collaborate with other children. The findings also highlight the *positive experience* that involvement in such a process can offer this population.

Author Keywords

Participatory design, autism, children, educational games

ACM Classification Keywords

H5.2. User Interfaces: User-Centered Design.

General Terms

Design, Human Factors

INTRODUCTION

Technology is increasingly being seen as a beneficial addition to the strategies for supporting children with Autism Spectrum Disorders (ASD) [8]. Children with ASD typically exhibit an affinity for computers [3,20], which provide a safe environment to learn and practice skills that they may find difficult in everyday life. Computers have a number of features particularly appealing for children with ASD, such as the ability to repeat tasks and easily correct errors [20]. However, technology aimed at this population is often designed without the involvement of the children themselves. This may be due to the impairments typically associated with ASD [1,25], and the challenge of managing these impairments to allow the children to participate successfully in the technology design process.

A triad of impairments typically characterizes ASD including social impairments, communication difficulties (incorporating a lack of imagination) and rigid and repetitive behaviors [1,25]. Each of these impairments present a unique challenge for designers intending to work with this population. The process of designing technology often involves working with others as well as generating, communicating and progressing creative ideas which, given the triad of impairments, could be particularly difficult for children with ASD. However, involvement in the technology design process does offer an opportunity to practice social interaction and creative thinking in a more structured environment, which may be more suited to this population.

Participatory design (PD), a means of involving end users in the design process, is one method that has successfully involved children in the design of technology. Involving children as equal stakeholders or 'design partners' through PD offers a number of potential benefits. These include giving the children a sense of empowerment and challenge, providing them with an opportunity to develop new skills, and building their confidence both academically and socially [6,10]. This approach can also potentially result in more innovative technologies [6] and can give the children a feeling of ownership over the final product [11,24]. However, it is not known if these benefits would generalize to children with ASD or if children who have not participated would feel the same about the final product.

Benton et al. [4] began an investigation of the potential use of PD with children with ASD. The authors adopted a phased, analytical approach to overcome the different obstacles of involving children with ASD in PD sessions. The first phase, described in [4], involved a pilot study using a tailored design method, IDEAS, to investigate if this population were able to ***individually*** undertake activities typically involved in PD sessions. It was found that children with ASD do have the potential to be involved in these design activities, but often require additional appropriate support. Although there have been a few examples of similar work in this area [7,19], the benefits of the IDEAS method are that it is firmly grounded in the autism literature [1,25] and is based on the TEACCH culture of autism [18]. TEACCH is a program that is "an internationally recognized treatment and support modality for individuals of all ages with autism spectrum disorders" [18]. This ensures the IDEAS method takes into account and mitigates the full range of potential difficulties that might arise when working with this population.

The three main research aims of this paper are:

1. Can children with ASD work within a collaborative design environment, how does the existing IDEAS method need to be modified to support this and what implications does this have for them becoming full 'design partners'?
2. What are the potential benefits of involvement in a PD process for children with ASD?
3. Can using a PD process also provide benefits for children with ASD not involved in the product design?

This paper extends the IDEAS method by incorporating ***collaboration*** support, enabling it to be used with a design team including children with ASD. The extended IDEAS method, described in this paper, has been trialled with two groups of children with ASD over six design sessions focused on developing a math game. A detailed description of the method used is given with the intention of enabling other researchers to replicate the method in different scenarios to build on the results presented here. Due to the even greater social interaction and communication difficulties faced by children at the lower end of the autism spectrum this research is *initially* focused on those individuals diagnosed with high-functioning autism or Asperger Syndrome (AS). The research reported in this paper is closely related to, and will feed results into, a larger scale funded project. This project is focused on developing math-based tutoring software tailored to the needs of children with ASD, and so forms part of a coherent, integrated research agenda.

RELATED WORK

Participatory design has been used successfully with typically developing children for over a decade. Druin [5] has developed one of the most frequently used methods, Cooperative Inquiry (CI), and has also defined different roles that children can undertake within the design process [6]. These roles include user, tester, informant and design partner. The role of design partner provides children with the greatest opportunity to contribute to the design process, allowing them to become an equal stakeholder in the process. This involvement can help children to feel empowered, which can be a rare experience in childhood; particularly for children with special needs. However, as Frauenberger et al. [7] point out "the balance between empowering children and overburdening them with responsibility is a difficult one to manage" and therefore an important consideration in the development of any PD method for children. Additionally, much of the previous research in this area has focused on the benefits to the technology design rather than any potential benefits to the children themselves [10]. There has been some anecdotal evidence of typically developing children benefitting from participating in the design process, but this is often a secondary focus [15,17]. The difference in feelings of ownership and empowerment between children involved in the design process and non-participants within the same target population, has also rarely been considered.

There has been a limited amount of work undertaken to involve children with particular special needs in the design process. Guha et al. [9] have developed a framework for involving this population, based on the CI method. They highlight important aspects to be considered such as the nature/severity of the child's disability and the availability/intensity of support. Frauenberger et al. [7] state that using PD to give children with special needs control over creative processes "can be very liberating for them." In conducting a literature survey into different PD approaches they found 11 projects in which children with special needs, such as cerebral palsy, vision/hearing impairments and learning difficulties, were involved to some extent. Five of these projects included children with ASD, typically within a testing role, with some also incorporating parents or teachers as proxies for the children (e.g. [12,24]). In addition to these projects Kientz et al. [13] have also used parents and caregivers of children with ASD as proxies in the design of pervasive technology, and children with ASD were involved as testers and informants in designing facial expression recognition software [16] and a social skills development game [22].

Researchers have recently begun to involve children with ASD more fully within the design process, allowing them to undertake roles more akin to a design partner. Frauenberger et al. [7] involved a group of children, two boys with ASD and one girl with other special needs, in the design of ECHOES, a learning environment for social skills development. A separate group of typically developing children were also involved in the project. Both groups undertook a series of design activities specifically developed for the ECHOES project, as well as evaluating the prototype system. Although some of the activities were slightly adapted for the ASD group and allowed children to contribute some valuable ideas to the design process, they did not participate in every activity due to "logistical difficulties". Millen et al. [19] have taken the work in this area a step further and developed a method that could be adapted for use in other projects. Their PD method has been developed for involving children with ASD in the design of collaborative virtual environments and incorporates a series of structured activities. It has been trialled successfully with three boys (aged 13-14) with ASD, but does not appear to offer explicit support for collaboration within the group.

THE IDEAS METHOD

The IDEAS method was first presented in Benton et al. [4]. The development of IDEAS was guided by both the literature on the triad of impairments [1,25] and the TEACCH characteristics of the culture of autism [18]. The TEACCH characteristics cover the fundamental features of autism, with each characteristic being a result of impairments in one or more areas of the triad. These characteristics (with some resulting behaviors highlighted in brackets) include: difficulties with the concept of meaning; focus on details and lack of ability to prioritize their relevance; distractibility; concrete vs. abstract thinking (inc. limited social skills/emotion empathy); combining or integrating ideas; organizing and sequencing; generalization; visual vs. auditory learning; prompt dependence (inc. difficulty with initiation); strong impulses and, excessive anxiety (inc. attachment to routines). The IDEAS method was designed to support each one of these characteristics, to prevent any one of them becoming a barrier to successful involvement in the design process.

The original IDEAS method provided support to help children with ASD *participate* in typical PD activities. It was designed for use with *individual* children in a one-off design session involving (1) an introduction to the design topic, (2) discussion of previous experience/demonstration of similar software, (3) generation of own design ideas, (4) drawing out interface design of their best idea [4]. The method also included a visual schedule that displayed the sequence of these activities and acted as a checklist to document the child's progress. The IDEAS method was trialled with 10 children with ASD. The amount of support provided in each session (incorporating example ideas and template interface designs) was varied according to the needs of each child. It was found that children with ASD had the potential to take part in these creative activities, but some needed the additional support to participate fully.

In this paper the IDEAS method has been extended to further support children with ASD to *collaborate* within a design team. The extended method includes similar activities, but these activities are undertaken in more detail over six sessions with the ideas developed into a working prototype. It also uses a visual schedule in the form of a whiteboard to again allow the children to check off the tasks, as well as displaying other information about the session (Fig. 1). The design team incorporates children with ASD, specialist teaching staff and university researchers (including a researcher with the technical skills to build a computer-based prototype and another researcher with specialist autism knowledge). It is important that there are enough adults within the team to provide one-to-one support for each child if necessary. Adult team members help mediate social interaction where needed, enforcing social rules like turn taking and listening to others. Children are also praised for good examples of social interaction to highlight correct behaviour. This support can be decreased in later sessions, but is still available if required.

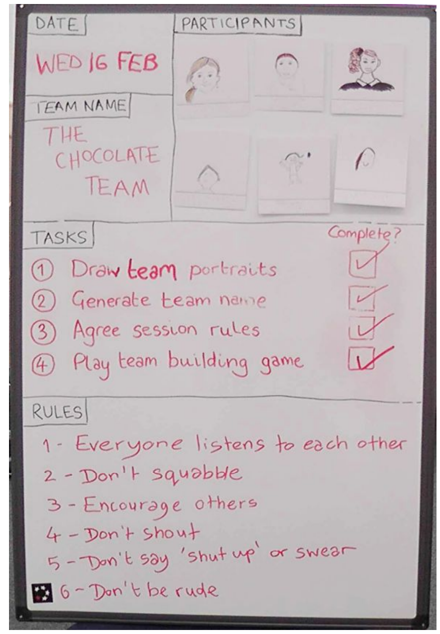

Figure 1: Visual Session Schedule

METHODOLOGY

Participants

The IDEAS method has been trialled with two groups of children with high-functioning ASD and two groups of typically developing children. However, this paper focuses solely on the results of the ASD groups. Each design team comprised three children with ASD (who knew each other), one teaching staff member from the children's school with whom they were familiar, and two university researchers with appropriate skills/knowledge. The children were aged 12-13 years, diagnosed with high-functioning autism by clinicians following DSM-IV criteria, and attended two different urban, non-faith specialist ASD schools. Group 1 contained two boys and one girl, and Group 2 contained three boys. The sessions took place on a weekly basis at the children's school and were run in a separate classroom. Following appropriate consents and ethical considerations all sessions were video-recorded, to ensure all ideas/discussions were captured. As a reward for taking part, the children were allowed five minutes at the end of each session to play a game of their choice on an iPad.

Session Content

The sessions were centered around designing a math game, chosen partly because children enjoy playing computer games, so this would add a fun element to the sessions. Also, as well as being a core curriculum subject, math is a subject high-functioning individuals with ASD often have an affinity for [14]. To help provide structure to the idea generation process the children were shown an existing math game, which involves answering basic math questions by shooting planes with the right answer on. They were then asked to focus their ideas on how to improve the way the game could give them positive or negative feedback and how they could be rewarded for winning the game, with the potential of feeding these results into the reward scheme of the math tutor. The reason for not giving the children a 'clean-slate' design problem was that in the previous IDEAS paper [4] it was clear some children with ASD were unable to generate ideas from scratch and it was important that this did not become a barrier to collaboration, the focus of this study. Below is a description of each of the six design sessions (with the TEACCH characteristics specifically supported during that session in brackets):

Session 1 Team Building *(concrete vs. abstract thinking - limited social skills/emotional empathy):* this involved structured activities such as agreeing to a team name, drawing each other's 'team portrait,' thinking of team rules (see Fig. 1) and building/playing a LEGO® team game (based on LEGO® Therapy [21] where each child was given a role i.e. designer, supplier and builder). These activities help initiate and structure the initial interaction between team members to support potential social difficulties.

Session 2 Context Setting *(concept of meaning; generalization):* this involved discussing the children's prior experiences of receiving feedback and being rewarded in school. The children then observed and interacted with four existing online and iPad-based math games, and discussed the positives/negatives/potential improvements of these. The discussion task helps the children to generalize past experiences within this new context and then the concrete examples of the design topic support potential difficulties grasping the topic context, i.e. a math game.

Session 3 Idea Generation *(combining and integrating ideas; prompt dependence):* this involved demonstrating an existing math game that was poor at giving feedback and rewarding the player. Each team member then drew out their own ideas, based on this game, onto three separate paper template interfaces (e.g. Fig. 3) for what happens if they get a math question correct (correct feedback), what happens if they get a question wrong (incorrect feedback) and how the game should reward them for winning. These ideas were then presented to the rest of the team. Templates were used to prevent the children being overwhelmed by a totally blank piece of paper, but at the same time to give plenty of scope to use their creativity and imagination. The individual ideas were then combined into three team ideas (correct, incorrect, reward), with each child responsible for making decisions as to which ideas to include for one team idea (supported by an adult), but no idea explicitly rejected. Any difficulties with combining ideas were supported through this gradual integration process and the one-to-one adult support. The idea generation process begins with paper prototyping, as using basic art supplies is an activity children are typically familiar with [6] and negates the need to teach the technical skills required to use specific computer software. Between sessions 3 and 4 the combined team ideas were transferred into Adobe® Photoshop® by a researcher with appropriate technical skills.

Session 4 Design Development *(concrete vs. abstract thinking)*: this involved showing team members the combined group ideas for the math game, now on the computer to help make the ideas more concrete. The team members then collectively discussed and agreed how to animate the prototype game, annotating ideas on a paper version of the interface (e.g. Fig. 4). Between sessions 4 and 5 an animated computer-based prototype was built, based on the annotated templates, by a researcher using Adobe® Flash®.

Session 5 Design Refinement *(concrete vs. abstract thinking)*: this involved refining the team's ideas into 'a polished product'. Team members were shown the initial computer animated (non-interactive) math game prototype and then collectively adapted printed storyboards of the prototype to improve upon the animation, sounds, look, etc. (e.g. Fig 5). Between sessions 5 and 6 a researcher refined the computer-based prototype to include these further ideas.

Session 6 Evaluation and Reflection: this involved evaluating the final prototype and reflecting on the PD experience. The children were shown the final math game prototype and completed surveys about their opinions of the prototype and of being involved in the PD sessions. They then produced a display of work from the previous five sessions, which involved writing down a list of activities and their likes/dislikes for each session. They presented this work to their Head Teacher. This overview of the sessions helps the children link what they have done and grasp the 'big picture' as well as a chance to show off their work.

The remaining TEACCH characteristics were supported through the overall session structure. To support difficulties with *organizing and sequencing,* each session began with an introduction and explanation of the tasks, a reminder of the team rules from the first session and a visual recap of the previous sessions. To support the preference for *visual learning* each task incorporated a visual component and a whiteboard was used to visually display session information including tasks and rules (Fig. 1). These explicit rules may also help to govern the social environment making children with ASD happier to participate within it. A different child in each session was assigned the role of ticking the completed tasks off to track progress. The whiteboard was also designed to help children focus on the 'big picture' rather than *irrelevant details,* by highlighting the key tasks. To help *reduce distractions* the sessions were conducted in a quiet environment and were designed to be engaging and fun with a relaxed atmosphere. Additionally to mitigate *strong impulses* related to special interests and *excessive anxiety* about the unfamiliar nature of the sessions, the sessions were run in school and incorporated a member of teaching staff familiar with the children's hobbies and interests. Finally to *reduce anxieties* about the change from their normal routine the session structure was kept consistent throughout and undertaken at the same time and place each week.

Surveys

During the final *evaluation and reflection* session the children were asked to fill in a survey to determine their opinion of the final math game prototype. The teachers were then asked to administer another survey to find out the children's opinions about the overall experience of participating in the sessions. The display of work produced in session 6 served as a memory aid for this to help the children remember the previous sessions. The teachers also filled in a separate survey to gather their personal feedback on the sessions and whether they thought it was a positive or negative experience for the children. The surveys given to the children used simple language, included 11-12 questions and incorporated a Smileyometer Likert rating scale [23] (Fig. 2) to determine the children's opinion of different elements of the game as well as the different PD activities they took part in. The Smileyometer is an established instrument, co-designed by children, who altered the neutral state as it was deemed to look angry [see 23]. This rating scale was explained before the children began the first survey and there were no difficulties understanding it. Although children with ASD can have emotional-processing difficulties, this does not extend to such stereotypical images of faces [2]. The remaining questions were multiple choice and the options for each question were typically Yes/No/Not Sure (or Maybe).

Figure 2: Smileyometer rating scale used in surveys

After each of the final sessions the researchers returned to the respective schools to show the prototype math game to a further 5-6 children with ASD who were *not involved* in the sessions. The children were not told who was involved in the design of the game. After seeing the prototype game the non-participants were asked to complete a very similar survey about their opinions of the game. This was done to compare their sense of ownership and motivation for using the game against the children that had been involved in actually designing the game.

RESULTS

The video data from each session was transcribed and coded using the triad of impairments and the individual TEACCH characteristics to highlight occurrences of successful participation as well as any specific difficulties related to typical ASD characteristics. The ideas and final prototype designs were also analyzed to look for common or distinctive themes and the processes the idea development had followed to achieve the final prototype design. The results of this analysis are discussed below.

(1) Working within a collaborative design environment

The children in both teams were able to undertake all of the tasks set during the sessions. All the children contributed ideas, gave their opinions on other ideas, and were able to collectively agree on a final idea (Figures 3 – 5 show how Group 2 progressed one of their prototype designs.).

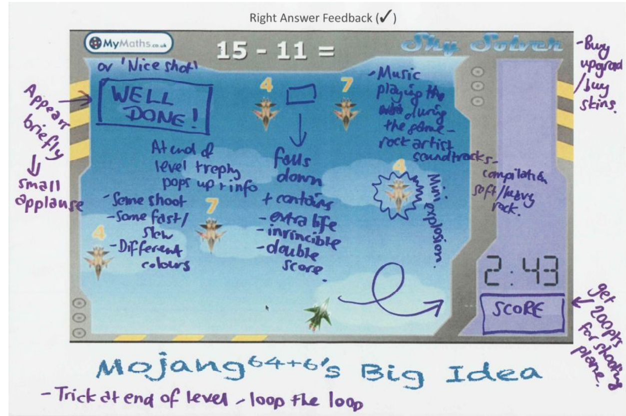

Figure 3: Group 2 combine their individual correct feedback ideas during Idea Generation session

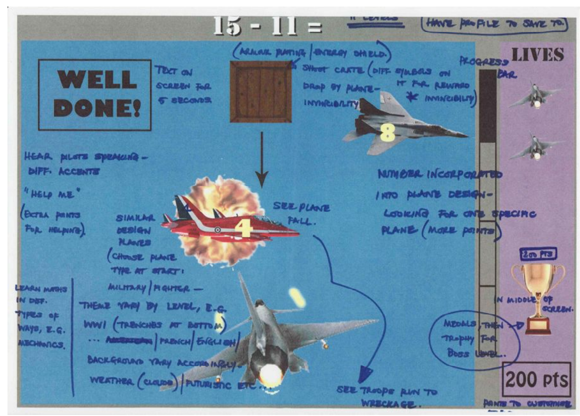

Figure 4: Group 2 add sound/animation to correct feedback ideas during Design Development session

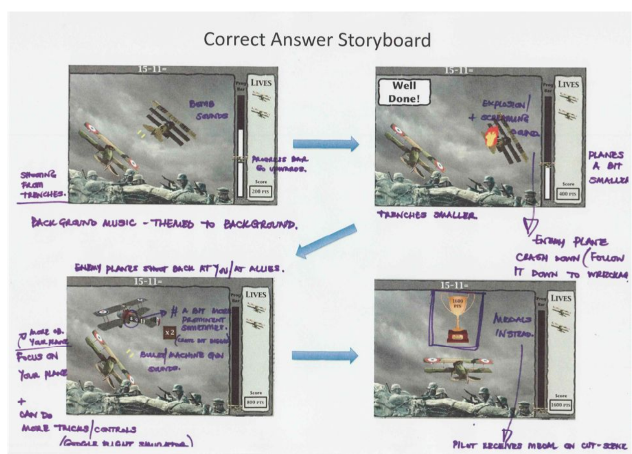

Figure 5: Group 2 refine the correct feedback prototype game storyboard during Design Refinement session

(Larger images can be viewed at: http://goo.gl/oc96f)

During the *idea generation* session all of the children were able to generate their own individual ideas (sometimes with extra support from an adult, who would ask questions/make suggestions as a prompt) and contribute to the group idea during later sessions. Some children contributed more ideas than others, but this is often the same with typically developing children. Idea initiation varied quite significantly between groups. Group 2 rarely needed prompting and began generating ideas from the start of the session, sometimes without prompting. In contrast, Group 1 were not initially forthcoming with any ideas and the adults adopted a method of prompting the children to think of ideas for a specific element of the game. It was observed that as sessions progressed the children gained more confidence in initiating ideas without direct prompting and in later sessions were able to generate many ideas without any adult support. The children in both groups generally preferred to express their ideas verbally with an adult annotating these ideas on a paper template of the interface. They occasionally drew specific interface elements, but most disliked writing and in both groups there was one child that had very limited reading/writing skills.

The social interaction across the two groups varied dramatically and this influenced the level of collaboration between the children. In the early sessions any form of interaction between the children in Group 1 was extremely limited, with the adults mediating the interaction that did happen. However, by the fourth session the children began to acknowledge each other's ideas, suggested further ideas based on another child's idea and even occasionally had social conversations without an adult involved. This progress in social interaction continued throughout the remaining sessions. The vignette below shows two children in Group 1 compromising on an idea for giving feedback:

[C wants the plane to turn into confetti if you shoot the right answer and M wants it to burst into flames]

C: Maybe if you get the wrong one it burns into flames

M: Yeah ok that's alright

Teacher: Yeah..well done that's a good one

C: Compromise [plane can burst into flames if you shoot the wrong plane and turn into confetti for the right one]

There were many more occurrences of social conversation in Group 2, particularly as two of the boys had a shared interest in gaming. This appeared to help collaboration between these boys as they were happy to expand on each other's ideas from the start, for example:

[L and G discuss mini game ideas for the reward scheme]

L: Yeah I think that shooting the right crate would be a good one

G: Yeah you could have 3 modes

L: Yeah 3 I think

G: So you could have like a survival mode, a sort of shooting crates one and endless just sort of mode

This greater collaboration helped increase the creativity of the ideas generated by this group involving imaginative concepts such as incorporating feedback through newspaper stories and an incremental storyline as an intrinsic reward. However, it is not known whether this is due to different manifestations of ASD or simply individual differences between the children. This would be a focus of future work.

The third boy in Group 2 often struggled to get his ideas heard and an adult had to step in and share his ideas so the others would listen. During the later sessions the other boys listened to him more and considered his ideas. By the end of the six sessions both groups demonstrated the ability to build on each other's ideas, suggest compromises where there were disagreements and compliment other's ideas:

[L is describing his idea for the progress bar]

G: Yeah that's actually not bad

L: And also the plane should be moving upwards on the bar

G: That works yeah…that's quite good

In both groups one of the children emerged as the dominant group member dictating the discussion and initiating significantly more ideas than the other children. In Group 2 this was evident right from the first session as one boy regarded himself as a 'gaming expert' and saw himself as having more knowledge than the other two boys. In Group 1 this happened in later sessions as one boy grew in confidence and often 'jumped in' with ideas if other group members were taking time to think. When the dominant group members took over the idea discussions the adults often had to ask the other group members for their thoughts to get them involved in the discussion again.

(2) Potential benefits of PD for children with ASD

Involvement in the PD sessions was a significant deviation from the children's normal routine. However, no child appeared distressed due to participating in the sessions, nor was any unable to participate because of anxiety related to the routine change. The children frequently checked the whiteboard displaying the visual schedule as they came into the classroom to see what they would be doing. The action of ticking off the tasks on the board helped increase the children's engagement in the sessions and they often volunteered to undertake the role for that session. Very few deviations from task were noted in either group and the children generally appeared to be engaged in the tasks. The task of designing a game proved to be a very successful topic in capturing the children's interest. It also tapped into a vast area of knowledge all of the children appeared to have, which in turn gave them confidence to participate by sharing their own ideas and opinions.

Some minor incidents of repetitive behaviour were noted in both groups. In Group 1, one boy would repeatedly share his opinion of a particular game element he did not like, finding it difficult to move on and accept this could be changed for the next session. This was overcome by repeated reassurance it could be changed, and prompting him to re-engage in the current discussion by asking for his opinion on suggested ideas. In Group 2 another boy frequently brought up the same idea and was fixated on everything being as realistic as possible. It was difficult to mitigate this particular issue during the sessions, due to the difficulty of finding the balance between progressing ideas and not discouraging the children from sharing their ideas.

The survey results were analysed to determine the success of the overall PD experience as well as the final prototype. For the PD experience the level of success was measured by the children's enjoyment of the tasks and working in a team as well as if they would choose to take part again and recommend a friend to take part. In this survey all the children were positive in their feedback stating that the activity of designing a math game as well as the experience of working in a team was either 'Good' or 'Really Good'. All the children except for one would definitely take part again (the other child said 'Maybe') and they would all rather work with the team than on their own to design the game.

(3) Potential benefits for non-participants

For the final prototype the level of success was measured in terms of whether the feedback elements would enforce the desired behaviour in the game (i.e. getting the answer right), if the reward scheme would encourage the child to continue playing the game, if the child liked the different elements of the game as well as whether they would choose to play it and recommend it to a friend. Both the children in the design teams and the children that were *not involved* were happy with the way the game gave feedback, but were less sure about the reward scheme with just under half the children from both groups saying the reward would encourage them to play the game for a long time. In terms of the look, sounds and animations in the game both groups of children rated them on average 'Good' to 'Really Good'. However the children *not involved* wanted to change a lot more game elements, frequently not because they disliked it but because they had their own idea that they thought would be better. Five out of six design team members, if given the choice, would choose to play the game, whereas just over half the children who were *not involved* would do the same.

DISCUSSION

The trial of the extended IDEAS method has so far produced some promising results regarding the involvement of children with ASD in PD sessions. The discussion has been framed around the TEACCH characteristics [4], which underpin the IDEAS method, to determine the successful elements of the method and where further work is needed.

The Concept of Meaning: introducing the design task within the context of existing games the children were familiar with helped engagement. Building up the low-tech prototype game excited them and helped them to imagine what the final game would be like.

Focus on Details: with respect to the session the visual timeline helped the children progress and know what they had to achieve before the end of each session. Having one-to-one adult support available helped children who got stuck on one idea to move on and re-engage, without affecting the rest of the group's progress.

Distractibility: the game design topic helped spark the children's interest in the sessions decreasing the likelihood of distraction from task. One-to-one adult support helped children concentrate on individual tasks and also helped bring disengaged children back into the group discussion.

Concrete vs. Abstract Thinking: the incorporation of concrete computer-based versions of the ideas at each stage helped the children imagine the possibilities and generate more creative ideas, for example the idea that integrated a storyline within the game and doubled up as a reward at the end of the game. The use of weather to show feedback as well as showing popularity through newspaper articles showed capability within both groups to generate more abstract ideas. Adults facilitating the interaction between the children was important, asking questions such as '*M what do you think of C's idea?*' to encourage the children to acknowledge each other and not just talk to the adults. This facilitation was required throughout but the children gradually initiated more interaction with each other during later sessions, demonstrating the ability to build on others ideas, compliment each other and start social conversations.

Combining or Integrating Ideas: the staged collaboration process ensured the children became comfortable with idea generation before working as a group. The consistent structure of the idea generation tasks also gave the children plenty of opportunities to practice their idea generation and collaboration skills. This was evident in the later sessions where children were increasingly building on each other's ideas. This process ensured no child became upset when, for example, their idea was not included. The adults helped support the children to come up with solutions to combine their ideas where they wanted different things.

Organising and Sequencing: beginning the session with a recap, going over the session tasks and ending with a description of what would happen next helped children understand where they were in the process. The act of ticking off each task also helped the children keep track of the current task and what was still to come. The idea generation tasks were kept to the same format across each session starting with ideas for i) correct feedback, then ii) incorrect feedback and lastly iii) the reward scheme, so the children became very familiar with the session structure.

Generalisation: the children demonstrated the ability to apply their knowledge of other games appropriately within the context of the group's idea. For example, the incorporation of a player viewpoint similar to Google flight simulator and using only non-lyrical music based on the failure of other games to include lyrical music successfully.

Visual vs. Auditory Learning: the children were given a visual representation for each iteration of the idea, which appeared to be enough to support discussions. They were happy to verbally discuss ideas by pointing at the design. The visual nature of the sessions was particularly important for involving the children who were unable to read and adult support was required for any writing, again highlighting the need for one-to-one adult support. One teacher also commented "*I think the way the sessions were structured, visual and recapped was brilliant! There were visual examples for them to get ideas from but not copy which made them use their imagination*."

Strong Impulses: the children were given time to discuss any special interests and the adults tried to suggest ways of incorporating these into design where appropriate, if the children were unable to. The teachers were very good at trying to incorporate their interests into the design tasks, e.g. for a child that liked The Simpsons reframing the question as '*What would Homer say?*' This highlighted the importance of involving teachers as well as incorporating the children's hobbies and interests.

Excessive Anxiety: the children were told during the first session that they were free to leave any time they needed a break, but the familiar environment, the involvement of a familiar teacher and the one-to-one adult support helped ensure that no children had to leave the sessions for any reason. The children's preference for routines was used positively in the consistent session structure and the same regular weekly time slot. Adult support was needed for discouraging some negative behaviour such as a child answering every question with the same answer '*alright'*, even when this was an inappropriate answer. The child was encouraged to give another answer and praised for doing so.

Prompt Dependence: this was one of the main challenges with Group 1. The teacher adopted a method for dealing with the children not initiating ideas, using lots of prompts. These prompts began as direct questions about specific parts of the design and then gradually moved on to more open-ended questions as the children's confidence in sharing their ideas with the group increased. This indicates that the adults may need to start off in a directing role and move to a supporting role in later sessions, to give extra help at the idea initiation stage and then allow the children more freedom to develop their ideas. This prompting technique should be formalized, in future work, within the IDEAS method so any adult can use it. However, the teacher's role should also include reinforcing social behaviour as it is taught in class.

CONCLUSION AND FUTURE WORK

This paper described the further development of the IDEAS method for involving children with ASD in PD. This work started with three main research aims and the extent to which these have been achieved are discussed below.

(1) Can children with ASD work within a collaborative design environment and potentially be design partners?

The outcomes of the study indicate that children with ASD can take part in PD sessions and potentially offer value as design partners with the support provided by the IDEAS method. The children were able to generate appropriate creative ideas, collaborate with both adult and child team members and compromise to collectively agree on a final group idea that fulfilled the initial brief. To support this collaboration the IDEAS method was extended to include one-to-one adult support for each child within the design team, providing additional prompts where the children struggled to generate ideas or communicate with other team members effectively. The method also included rules to help govern the social environment and began with 'team-building' activities to provide further structure to the initial social interaction. Finally the idea generation process was staged to gradually introduce the children to combining their ideas with others and making compromises where there were differences of opinion. Collaborating with others certainly did not come naturally to the children in this study, but what has been shown is their ability to learn to improve this skill over a series of sessions involving a consistent structure and adult support.

The outcome of this study indicates the potential this population has in becoming design partners. It is also important to recognize not every ASD characteristic is a possible barrier to participation in PD; this population has a number of strengths that could be of benefit to this process. For instance repetitive behaviors in activities related to their special interest and a predisposition to technology [3,20] can help increase engagement in sessions. However, during the PD process more time does need to be dedicated to building up the children's collaboration skills, with adults providing extra support for this initially and then gradually fading it out as the children demonstrate the ability to discuss ideas, listen to others and compromise unprompted.

(2) What are the benefits of PD for children with ASD?

The teachers in both design teams cited a number of benefits resulting from the children's involvement including: learning better team work skills, turn taking, compromising ideas and gaining confidence to voice opinions. These positive effects were reflected in the children's desire to take part again and continue working within the team environment. The children rated being able to generate their own ideas as either 'Good', 'Really Good' or 'Brilliant'. Furthermore, the teachers involved in the sessions, and the Head Teachers that the children presented their work to, were very positive about the overall experience, particularly about the team-working skills the children gained, and one teacher commented:

"All the sessions were positive, but I think it [the most positive aspect] *was watching their confidence grow and the relationship between the children and different adults grow, which was done by each session seeing their ideas come to life and the adults listened and took on board what they said."*

The teachers' comments also highlighted the sense of empowerment the children experienced with one teacher remarking: *"They got to do something fun and be part of the process"* and another *"…it was also a big confidence boost for all 3 to be part of something and see their own idea develop"*.

(3) Do any benefits extend to non-participants?

There was a difference in the ownership and motivation to use the final prototype between the participants and non-participants. It was clear that involvement in the design process increased the children's sense of ownership and motivation, with less suggested changes and an increase in likelihood to play the game and recommend to a friend. This was also highlighted in the importance for the children in Group 2 to be acknowledged in the credits of the game, with one child stating *"I'd play the whole game just to see credits with my name in."*

Limitations of this study

Due to the time consuming nature of running PD sessions it has not been feasible to trial the IDEAS method with more groups. Therefore despite the positive outcome of this study it is difficult to generalize the results and conclude that all high-functioning children with ASD would be able to participate in PD using the IDEAS method. These results also do not currently apply to individuals with low-functioning autism. It is acknowledged that the task of 'designing a game' was chosen to specifically appeal to this population and the choice of a different design topic may have been less successful. However, it was important that the appeal of the task was not initially a barrier to collaboration and it is hoped that the lessons learned in this study could be applied in a research scenario with a less appealing design topic. It is possible that missing lessons could have contributed to the children's positive view of the sessions, however pleasant reward times are incorporated into most lessons, the children are often brutally honest and can find disruption to their familiar routine stressful, which would make a 'halo' effect unlikely.

A number of other external factors could also influence the success of the method such as the children's individual interests and motivation to take part, having a teacher willing to support the process, as well as choosing the right mix of children who are willing to work with one another. It is also important to point out that the IDEAS method is being developed incrementally with the end goal being the full inclusion of children with ASD as design partners within the PD process. Although this work has shown there is the potential to achieve this, a full PD study would need to be undertaken over a longer period of time and result in the full design/build of a product to verify these results. What has been shown though, in two different schools, is that children with ASD do have the potential to participate. Furthermore by undertaking careful planning before the sessions and using a method like IDEAS to support the process, then there is a good chance of success as well as to give the children a positive experience.

PD Session Guidelines

From the experiences in this study we offer the following preliminary set of guidelines, framed by the relevant TEACCH guidelines, to heighten the pleasure and well-being effects of participants with ASD in PD sessions:

1. *Concept of Meaning:* Ensure the children are familiar or can identify with the design topic in some way.
2. *Distractibility:* Identify the hobbies and special interests of each child and incorporate these within examples and discussions, particularly as a way of engaging a distracted child.
3. *Concrete vs. Abstract Thinking:* Be prepared for very direct criticism. If the children do not like something, expect them to say so. Do not take offense and give clear explanations/solutions to issues.
4. *Organising and Sequencing/Visual vs. Auditory Learning:* Ensure the children know what activities to expect during each session and represent these in a visual way wherever possible.
5. *Excessive Anxiety/Prompt Dependence:* Involve an enthusiastic member of teaching staff, who 'gets' the project, knows the children well and is able to reinforce the support structure and improvise where necessary.
6. *Strong Impulses:* Use the personal strengths of each child to build up their confidence in the sessions.
7. Finally, involve researchers from a range of backgrounds, as it is important to have adult team members with technical skills as well as the psychological knowledge to best engage the children.

As both groups were able to generate ideas given a basic game framework as a starting point, future work could determine whether the children can cope with less support for the initial idea allowing them even greater scope for creativity. The method could also be trialled with lower functioning children to see if they are able to participate with the same level of support, need an increased level, or whether the type of contribution they could make to the design process would need to be reconsidered.

The positive results reported in this paper demonstrate that the potential benefits of incorporating typically developing children in PD are also applicable to children with ASD. Therefore excluding this population from involvement in the design process is not only a possible detriment to the end product, but is also depriving this population of a potentially rewarding and pleasurable experience. It is hoped though, that as a result of this work, designers will recognise the valuable contribution children with ASD can make to the design process and seek to involve them by using a supported design method such as IDEAS.

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