The Participation of Children in the Design of New Technology

A discussion paper

by Ben Williamson, Futurelab

September 2003

EXECUTIVE SUMMARY

The participation of children in the research, design, and development of educational new technology has gained popularity in recent years, with methodological approaches ranging from usability testing at the end of a production cycle to long-term inter-generational partnership. Despite this, most commercial organisations developing new technology for children do not involve their target group in the design phase at all. In the USA only 5% do so. Most participative design approaches are currently university-led.

Existing participative approaches draw on several rationales. Many researchers argue that children learn best when engaged in authentic activities that matter to them in their everyday lives rather than abstract conceptual tasks. Authentic learning can only occur if we work with children on what is authentic to them. Additionally, a great deal of participative design is based on constructivist models of learning, in which schools are viewed less as environments for assimilating data, and more as environments of active inquiry, investigation and constructing new understandings.

Other researchers are more interested in the forms of democratic participation promoted by the involvement of children in design. The democratic ideal, they suggest, is one in which children's voices are heard and have an impact on their education. It has been argued that much new technology designed without the participation of users is constrictive, only offering opportunities for reactive interactivity rather than the elasticity to stretch students' potential for innovation and creativity.

The most democratic forms of participative design involve children in long-term design partnerships, but such approaches remain to date largely university-based and difficult to implement both commercially and in schools. An iterative 'informant design' methodology, which brings children and teachers together with researchers and designers in a staged process, is described, with recommendations for practitioners in education and the commercial sector in developing approaches to including children in new technology design.

INTRODUCTION

In recent years there has been growing debate around the extent to which children can or should be involved as participants in the design process when developing new technology[1] for children. Participative approaches[2] range from the short-term involvement of children in the evaluation of near-complete products, to regular and frequent involvement throughout a product's development cycle. At the root of these approaches are some fundamental questions about the role of new technology in education and, more importantly, how the balance in interactions between children, their teachers, and designers, might stimulate new forms of learning, and contribute to better learning resources.

Since the late 1990s, participative design with children has been most influentially exemplified by the work of the Human-Computer Interaction Lab at the University of Maryland. Their 'cooperative inquiry' methodology (Druin 1999) treats children as long-term design partners alongside educators, computer scientists and artists. The approach regards children and adults alike as equal stakeholders (Druin 2002) in multi-disciplinary and inter-generational teams,

[1] For the sake of brevity, the term 'new technology' is used to mean interactive media, including websites, CD-Roms, and other interactive software, as well as hardware and, of course, any innovation in between.

[2] The terms 'participative approaches' and 'participative design' are used in a broad sense to describe any level of child or user participation in new technology design, not to describe one particular approach.

participating in all stages of research, design, development, and technology prototyping.

This mode of inquiry is not, however, exclusively new. Rather, it draws on a range of techniques developed over the last few decades that have recruited children into specific roles in the design process. Seymour Papert's research group at MIT, for example, had already begun to experiment with child participation in the late 1960s and early 70s (Papert 1980). In the Scandinavian countries in the 1970s and 80s, 'participant design' practices with adults were in evidence across a range of industries as worker involvement in the design of working practices, motivated by trades unions, was regarded as a catalyst for societal change (Bjerknes, Ehn & Kyng 1987). The 1980s also saw the growth of 'user-centred design' practices in commercial environments on both sides of the Atlantic (Gould and Lewis 1985). In the field of Human-Computer Interaction - a discipline which only came to fruition in the early 1980s - it has for some time been regarded as unusual for children to be excluded from design practices (Scaife et al 1997).

Today, then, learner involvement in design is increasingly becoming viewed as a common sense approach to avoiding the pitfalls of designing resources that children simply cannot stand, or cannot understand (Kafai, 2001).

Despite this involvement of children in design within academic research settings, however, within the commercial context user involvement in design schedules remains a persistently under-used strategy. Children's television provides a good example. On one hand, Ragdoll, the team behind *Teletubbies* and *Boohbah*, have pioneered work with children in the design phase of production, observing and utilising children's play patterns within the context of their productions. On the other, HIT Entertainment of *Barney* and *Bob the Builder* fame have only very recently begun to develop such approaches. For the small-scale multimedia development house, working to tight schedules and budgets, the incentive to find time to work with children in the development process must often seem slim. In the US, for instance, a recent Just Kid Inc (2002) report suggests that only 5% of organisations developing interactive media products for children involve their user group within a research and development process at all. Furthermore, Landauer (1995) reports that due to the range of practices in user involvement in the professional industries, there is little uniform agreement on the benefits of these approaches, with gains in performance varying widely, from 0% at NASA, to 720% at IBM, for example.

This guide provides an overview of best practices in the involvement of children in the design of new technology. It attempts to indicate how multimedia producers, working with children and teachers, can optimise the partnership to design better resources with and for children. From an academic perspective, these are approaches often marked by subtle differences in method. From a practical perspective, these are approaches often marked by subtly different jargon. This article clarifies what *user-centred design, participant design, informant design, learner-centred design, child-centred design, design-centred learning* and *cooperative inquiry* mean, and their practical implications for teachers and developers of educational resources. Given, also, that the focus here is on how children and adults can innovate together, the term 'best practice' is used with some caution, wishing not to replicate what Moldaschl and Brodner (2002) describe as an 'expertocracy' of either design or research practices.

Before proceeding to describe the methods, however, this paper first provides a rationale for children's involvement in design, based on both theories of learning, and theories of social participation in technological cultures that suggest children's involvement in the design process is important for a number of reasons. The final section makes some practical recommendations for designers and teachers who are, or wish to be, involved in designing new technology with children, for children.

1. RATIONALE FOR CHILDREN'S INVOLVEMENT IN DESIGNING NEW TECHNOLOGY

1.1 Theories of learning that suggest children's involvement in design processes is important

1.1.1 Designing authentic learning activities

Many researchers (Lave and Wenger 1991; Rogoff 1990; Brown and Palincsar 1989) claim that learners are motivated and most engaged when they are working on authentic tasks, that is, tasks that take place in everyday contexts and put into practice the knowledge learnt rather than simply working on abstract, conceptual tasks. In authentic tasks the activities and tools appropriately scaffold the learners (Wood et al 1976), enabling them to work independently at their own pace but also challenging them to develop to the next level of understanding and performance. Of course, this does not mean confining learning to the type of tasks children are already familiar with, but utilising the skills and experiences of children as explorers of the world, and emphasising the ways in which they construct knowledge and develop new skills.

Digital technologies arguably have the capability to support this type of learning. The challenge in designing new technology for children therefore is to create technologies and design interfaces that can best support this type of learning through performing the activity. If we are to design digital resources that enable children to participate in authentic activities, then we need to work with children in the design process in order to understand what activities are likely to be authentic *to them*.

1.1.2 Designing tools to enable children to construct their own knowledge

Seymour Papert's influential research group at MIT (1980) has generated significant interest over the last 20 years in 'constructivist' theories of learning. Constructivism conceives of learning as a process of knowledge construction, with children utilising their existing knowledge and skills to accomplish something they previously would not have been able to do. Researchers in this field have begun to suggest that children's learning with new technology should be less about the 'consumption' of resources designed by adults, and more about their 'construction' by children. Eisenberg et al (2003), for instance, re-conceive the traditional children's landscape of 'kits and toys' as a landscape of 'empowering tools and techniques with which children can create their own personalized, high-quality artifacts' (37). This model envisages the process of learning inside school as less about the assimilation of data and more about active inquiry and investigation. While there have been some significant critiques of this approach[3], nevertheless a model of learning as a process of drawing on previous skills and knowledge to construct new understandings would imply the need to involve young people in the design process at an early stage, emphasising, as it does, that the end users of digital resources are not simply a 'blank canvas' into which information can be poured. Unsurprisingly, then, a great deal of constructivist theory has come to underpin learner-centred design approaches.

1.1.3 Designing engaging resources for self-motivated learning

Much attention has also recently been given to the learning potential exhibited through children's engagement with video games, most notably in Prensky's (2001) and Gee's (2003) book-length studies of video games as learning media. Not only are the aesthetics of video

---

[3] Simon (1987), De Corte (1990), Clements and Gullo (1984), and Hughes (1990) (all cited in Wegerif 2002) have criticised Papert's belief that children using the programming application LOGO would develop general problem solving skills. Rather, they see LOGO, and the constructivist principles it exemplifies, as a useful tool for teaching practices that might stimulate transfer - not as leading inevitably to the development of skills that can be utilised in other contexts.

games motivating and engaging. These studies, amongst others, suggest that young people playing them are often involved in forms of learning within the context of gameplay itself. Gee, for instance, points out that most players do not read the instruction manual that accompanies newly purchased games; instead they 'learn' the rules and the controls through active engagement with the game. At a more complex level, Gee goes on to argue, players are engaged in the active construction of character identities, mediated both by the player's personal values and beliefs, and the context of the game world.

The drive to 'tap into' what motivates children about some new technology is, arguably, one of the central projects of child-focused participative design approaches. As adult designers, teachers, parents, and researchers, we wish to understand more fully what tasks children find authentic to their everyday experiences and, working together with children, to mobilise authentic and engaging activities within the context of learning. A child-focused design approach may help design teams to reflect not what adult educators, parents, academics and designers consider appropriate for children (Kafai 2003; Druin 2002), but what children themselves identify as motivational, engaging, challenging and fun about new technology. Creating tools and resources that are authentic to children's experiences, and which scaffold them sufficiently to develop further skills, experience and knowledge, is at the core of the approaches described in the second section.

1.2 Theories of social participation in technological cultures that suggest children's involvement is important

1.2.1 Children's participation in technological cultures

The US Just Kid report (2002) which suggests only 5% of organisations developing interactive media for children involve the user group within the research and development process at all, points to some larger issues concerning children's social participation in a technological culture.

Recent years have seen vast surges in the presence of technology both at school and in the home, as well as in community and youth centres, city learning centres, and even, in the shape of mobile phones especially, on the person. In the UK, many schools are being connected to high speed broadband internet, and digital media projects are flourishing. In addition to this, a very large number of children play video games at home, with or without friends, and chat rooms have boomed in popularity.

1.2.2 Democratic work processes

Despite these high levels of access, however, we need to caution against assuming that children's use of computers in or out of school offers them participation in either new social practices or higher levels of control over their own learning processes. Indeed, many of the learning materials delivered online are often little more (sometimes nothing more) than point-and-click, rote exercises, and arguably less useful than most traditional classroom activities. Technology alone is not enough to promote children's increased participation in learning processes.

Amongst others, Bannon (1990) argued that 'our present-day design and utilization of information technology… has tended to restrict, rather than expand human potential' (260). More recently, Feenberg (1999) has suggested that 'advanced societies enrol their members in ever wider technical networks which… constrain behaviour significantly' (128). From these perspectives, interaction with new technology is mediated through the demands of the interface itself, offering to the user 'fixed' opportunities rather than the freedom and elasticity to innovate to their own purposes. From the learners' perspective, this is manifested as a kind of 'reactive' interactivity rather than real user control (Buckingham and Scanlon, 2003). From a teacher's perspective, many of these such resources are often felt to stifle rather than promote classroom creativity and innovation. What might be suggested, therefore, are new approaches which promote forms of democratic participation in the design of technology. As many commentators have pointed out, democratisation in technology is about recognising participant interests, or the demands of users, and challenging the kinds of institutionalised 'technocracy' that precludes these interests from consideration in technological developments (Bjerknes and Bratteteig 1995; Feenberg 1999).

Furthermore, Bjerknes and Bratteteig (1995) argue in respect of technology design for the workplace, an argument that can be interestingly applied to educational settings, that there must be a connection between the democratic process of design, and the democratic result produced:

The democratic result should be a workplace - and a working life - in which everybody has a voice and in which all voices are heard and have an impact. A democratic process is a process in which everybody has a voice and in which all voices are heard and have an impact (90).

Not only is democratic design imperative, Bjerknes and Bratteteig argue, but it should lead to broader forms of democratic participation across the workplace after the design intervention.

1.2.3 Democratic classrooms

In a school context, a notable example of these processes of democratic participation in action is the Room 13 initiative at Caol Primary School in Fort William, Scotland. Room 13 is entirely run by a management team of children aged 8 to 11 years from the school, who arrange their finances, raise funds from local businesses, ensure the studio is kept tidy, employ an artist-in-residence, present at national conferences, and arrange exhibitions of Room 13 art at public galleries. The studio is open to any children from the school, who are free to come and go as long as their normal class teachers approve and they agree to catch up with any work missed. Children from Room 13 have won several major art awards for young people, and have also been awarded a NESTA grant to expand their operations, including opening associated studios in other local primary schools. Room 13 is a wholly participative and democratic learning community where children learn art skills, and, additionally, where they engage with philosophy, organise cross-cultural exchanges with schools from abroad, and have developed their own business plan to insure their future existence (www.room13scotland.com).

Another example of similar processes can be found in Bath, England, where a recent initiative named 5x5x5 has seen five nursery schools partnered with artists and cultural centres to explore the possibilities arising from child-led activities. Already the organisers report that the inquisitiveness of the young children involved leads to creative learning which closely matches published national guidelines.

Democratic participation in the design of learning experiences, then, does not necessarily mean that curricula need to be toppled. Rather, they need to be framed within the context of children's authentic activities so that children see their learning as a process in which they have a say, not one in which learning activities are prescribed according to abstract goals.

In working with children on the design of new media and technology, clearly the democratic ideal is for children, as well as teachers, researchers, and designers, to participate equally and share their expertise for the benefit of all. This kind of equity is, as Knudtzon (2003) argues, difficult to manage when children and adults have already developed specific social roles demanded of them by educational institutions, the home, workplace and, more broadly, social and cultural politics. The extent to which it is possible to work as equal participants in democratic forms of design is, then, contended, and initiatives such as Room 13and 5x5x5 remain, at present, novelties.

The next section defines the characteristics of the most influential participative design practices to date, before examining the appropriateness of democratic approaches to the design of new technology with and for children.

2. FROM CHILDREN AS USERS AND TESTERS, TO DESIGN PARTNERS (AND STOPS IN BETWEEN)

2.1 Users and testers

2.1.1 Defining the terminology

In the influential formulation that Druin (2002) provides, users and testers are regarded as having distinctly different roles in the development of new technology and interactive media. According to this the roles are defined as:

1. User: the child is observed as she uses *existing technology* so that *future* technology may be changed or enhanced
2. Tester: the child is observed as she uses *pre-release prototype new* technology and is asked for direct feedback to *inform further iterative* development

These are definitions which may not fit with more popular understandings of the roles. More commonly, the 'user' may be defined as anybody who 'uses' a piece of new technology. In the context of this article, the user therefore might be any child involved, to any extent, within the research and development process. However, many critics in the field of child involvement are beginning to question both the concept of 'users', and their role in new technology design. Most notably, 'user' can refer to either a child or adult; most commentators would agree that different methodological approaches are required for each. Furthermore, many commentators talk of 'user testing', or 'usability testing'. In user testing or usability testing the child participant is required only to ensure that new technology 'works', that is, has intuitive functionality, appropriate content and so on. The terms 'user' and 'tester' are, therefore, most commonly used together to denote someone recruited fairly late in the development of a new technology.

2.1.2 Defining the roles of users and testers

In the commercial realm user testing lacks clear definition (Kujala 2003). Wiklund (1994), for instance, describes a model of user involvement in which user testing is a critical component of an iterative process of product evaluation, and where the results of the user feedback are recruited into the redesign of the product or interface in question. In contrast, Webb (1996) describes a process of user testing prevalent in commercial multimedia development where it is confined to the post-production de-bugging phase.

Critiques of 'user testing' suggest that user involvement is often employed, particularly in the commercial sector, too late in a development cycle to make a significant contribution to an iterative and evaluative process (Scaife et al. 1997). Further, the types of interactions between designers and children involved in user testing have also been criticised for being too reactive, and for reinforcing the traditional notion that adults design for children as prospective users (Kafai 2003), rather than reinforcing a flattened hierarchy of design. Interactions of this kind may also only provide researchers and designers with limited insight into the potential of technology designed for children, since they are limited by constraints of the technology being used (Branton 2003). Plus, it remains up to the designers and researchers to decide which feedback to take note of and which to ignore (Scaife et al. 1997).

Markopoulos and Bekker (2003) attempt to address these issues in usability testing methods with children, describing children as 'test-users', and arguing that there has to date been 'no systematic methodological investigation of how such usability testing should be conducted' (228). They question how samples of children for involvement are selected, what environments are most commonly used, and how usability testing can be measured. Bødker (2003), meanwhile, has since the early 1990s been developing usability testing 'scenarios' that can provoke new ideas amongst participants in the usability testing process. Such scenarios, he argues, should be rooted in specific situations from the domain under scrutiny, but can also be designed as 'future' situations to allow participants to explore both how they would accomplish something within a current context, as well as with prototype materials in a speculative context. Arguably, this is a good practical intervention which ties blue-skies technological exploration to real-world issues.

While therefore the term 'user' is contested, and the role of the user even more so, nevertheless, involving users in the design process in these ways should not be discounted, and has proven successful in a great many case studies. What is more, this user testing approach is often co-opted into other processes, so that a more participative design process is likely to recruit members of a product's target group as both users being observed with technology at a very early stage, and as prototype testers during the product's iteration (Druin 2003). Indeed, such an overlap in methodologies form the bases of the child-focused, participative design approaches described next.

2.2 Informant designers

Informant design methodologies employ children at regular stages throughout the development of new technology prototypes. Pioneered by Scaife et al (1997), informant design questions the extent to which children can work as equal partners alongside adult participants, or whether adult supervisors should dictate their level of involvement. It also involves teachers as well as children in the process alongside researchers, designers and so on, and starts with early discussions principally motivated by specific subject-related issues. Both children and teachers are conceived as 'native informants' who are able to identify problems from within their educational experiences, and separately identify the kinds of problems that they encounter within specific subject-related contexts, since their views are likely to be quite distinct.

Based on these initial inputs, teams working with informant designers are able to transform the list of problems and issues into 'high level functionality requirements for multimedia implementation' (Scaife et al 1997: 346). What follows is a series of low-tech prototyping using everyday materials such as plasticine, crayons and paper, in which children and teachers, working together with designers, come up with designs and ideas for motivating activities and interfaces. A high-tech prototype is devised, and then iteratively tested and retested with the group. Indeed, low-tech and high-tech prototypes are often worked on in parallel, informing one another throughout iteration, rather than the high-tech model following on from the low-tech version in a linear manner.

The object of informant design is to discover something not previously known, rather than confirming what the design team thought it knew already. Rather than treating children and teachers as equal partners with designers, researchers, psychologists, artists and computer scientists, informant design involves intended user groups at various stages, where and when their expertise can be maximised and where their knowledge is required. Nonetheless, Scaife et al (1997) point out a number of problems with such an approach. They note that the presence of unfamiliar adults can act as an inhibitor to children who may therefore not put forward their points of view or ideas. The interventions of an adult facilitator can also become overbearing for children, who may begin to feel their contributions are being ignored. Scaife et al also raise the problem of an interdisciplinary team imposing their own views on classroom culture, especially if insufficient time is given to early stage research with the child and teacher informant groups and insufficient definition given to the prototyping phase.

2.3 Design partners

There are two principal approaches to working with target users as *design partners*. These are 'participant design' and 'cooperative inquiry'.

2.3.1 Participant design

Participant design (PD) (Schuler and Mamioka 1993) treats users as partners in the design process who contribute equally throughout the product development cycle and work more as peers within the design team than as end-users. Primarily, PD has been mobilised successfully with groups of adults who are able to work together as peers naturally. Indeed, PD is rooted in the Scandinavian approach of the late 1970s and through the 1980s which was principally trades union-motivated and intended to enhance professional development for, among others, graphics workers and hospital workers (see the UTOPIA and Florence projects (Bjerknes and Bratteteig 1995)). Many of the techniques pioneered in PD over the last two decades have been co-opted into other techniques, such as co-operative inquiry. The original Scandinavian work was, however, primarily adult-oriented and politically motivated; still, discussions continue as to the level of societal influence that democratic design processes can leverage (Bjerknes and Bratteteig 1995).

2.3.2 Cooperative inquiry

The cooperative inquiry methods developed by Allison Druin and her team at the University of Maryland have come to dominate HCI and interaction design conferences and publications in more recent years. This approach involves children as equal members within an inter-generational and multi-disciplinary design team, often comprising computer scientists, educators and artists (Druin 1999). It involves working with groups of children on a regular basis - usually once or twice a week in out-of-school clubs over the course of at least one year. Some children return in later years as more experienced facilitators. During cooperative inquiry research 'children and adults write in journals, work on low-tech prototypes, brainstorm on paper or sticky notes, draw pictures, and think about how technology should change' (Knudtzon 2003: 51). As a result of this process, both children and adults involved in the process are seen to proceed through four distinct roles or stages:

1. As a learner making sense of the process of invention
2. As a critic of what is good and bad in other inventions
3. As inventors suggesting new ideas
4. As technology design partners collaborating with adults and children in the invention process (Druin and Fast 2002).

Cooperative inquiry has its own established techniques, drawing on a range of activities that can be performed with children. The first step is 'contextual inquiry', during which adult and child participants, working as a team of researchers, 'observe and analyse the users' environment for patterns of activity, communication, artifacts, and cultural relationships' (Druin 1999). This allows both the children being observed to express their needs and wants from technology within their own social settings and in forms that are more comfortable than face-to-face interviews, and the researchers to note things down as they see them. This note-taking often takes many different forms, as verbal notes or as simple flow charts, diagrams and illustrations, as appropriate to the abilities, experiences and skills of the participants. It is usually not appropriate, for instance, to expect 7 year-olds to write extensive contemporaneous notes. Contextual inquiry thus allows the research group to identify the needs of the user group, and to proceed on to the next stage of participatory design. At this stage, the team develops low-tech prototypes of their ideas, including storyboards, plasticine models, drawings and sticky-notes.

The final stage in this process of cooperative inquiry is technology immersion. At this stage, the children are put in an environment with technology resources that they might not normally have access to, so that they begin to understand and explore potentialities that would otherwise be inconceivable to them. This freedom to explore technology is also observed using similar techniques to contextual inquiry, and subsequent low-tech and gradually high-tech prototype iterations emerge.

2.3.3 Design-centred learning

Druin (1999) has come to describe the types of learning that occur during cooperative inquiry as 'design-centred learning'. Highly constructivist in its principles, design-centred learning enables all participants to have a meaningful learning experience as part of working as a team - whether these are content-based learning experiences or skills in working together as interdisciplinary and even intergenerational teams. Learners in the process begin to see themselves as more than just users of technology, but rather inventors and innovators. It also has resonance with the influential research of the New London Group (1996) who describe ideal learning environments in terms of design. In a somewhat similar manner to Druin and Fast's (2002) conception of child as learner, critic and inventor, the New London Group suggest that children proceed through three 'design' phases in the construction of meaning and knowledge:

1. Using previously 'designed' resources to discover new things
2. 'Designing' meanings through interactions with and between these resources
3. Producing 'redesigned' resources that feed back into the first stage.

In the New London Group's conception, 'design' is more than technology invention - it is about identifying the social and cultural 'fixedness' of learning resources, and transforming meaning through utilising these resources alongside each other.

2.3.4 Problems with design partnerships

Cooperative inquiry has proven very beneficial for the students, designers and researchers involved. Of the approaches described it is clearly the most democratic in principle. However, it remains primarily university-led, and works well only with very small groups - precluding larger groups of children from participation at all. From this perspective, it presents only a very limited form of democracy. What is more, Druin (1999) and Knudtzon et al (2003), amongst others, report that most children above the age of about 10 years tend to describe what they see as the 'right answers', or what is 'supposed to be', rather than acknowledging the potential for creative thinking around technology. For such reasons, cooperative inquiry in particular has to date proved unsuccessful in working and designing with older children - though this should not preclude other researchers and designers from experimenting with methods that may work with the over-10s. Another drawback is, of course, the amount of time that needs to be invested in a program of cooperative inquiry. Dedicating upwards of a year with inter-generational groups of children, researchers, artists and computer scientists is likely to be outside the bounds of most project budgets and schedules - regardless of whether they are commercial or experimental ventures.

For these reasons, cooperative inquiry appears rather impractical. It is certainly a model which fits better within a university-funded research scheme, and while many of its basics can be applied in other contexts, it is a paradigm for design partnership which is unlikely to take hold in industry. From this perspective, informant design seems more practical to implement, and provides designers with child and teacher inputs staged to coincide with iterative development. In the practical implications which follow, we describe broadly informant design approaches which might benefit design teams or teachers wishing to involve children more in the process of developing new technology for education.

3. IMPLICATIONS AND RECOMMENDATIONS FOR PRACTICE

3.1 For educational new technology designers

The majority of the methods described in this document have been developed through university research programs. This does not mean that designers and developers from outside academia should not utilise them. Such child- or learner-centred approaches are possible within a commercially-driven context. Antle (2003), for example, describes a hybrid user-centred and informant design approach mobilised during the development of a web application for a major Canadian broadcaster. Over six months, 'children were involved as informants at the concept stage, informants and usability testers for critical tasks at the prototyping stage, and user testers at the beta stage' (59). Far from confining children only to user testing at a very late stage, then, a child- or learner-centred approach can demonstrably be applied within a commercial environment, as well as within a university lab.

Clearly, a full programme of cooperative inquiry could not be considered in this context. Utilising the input of children acting as informants is, however, feasible. These sessions can take place occasionally, and can be engineered to focus on specific issues, so that extended weekly sessions are unnecessary. Increasingly, schools are coming to recognise the benefits of educational new technology, and the staged involvement of staff and pupils will illuminate both the benefits and drawbacks of using technology in the classroom.

The challenge for the design team in the very earliest stage, working with teachers, is to establish the range of roles that children will be required to fulfil, and to map out what sorts of contributions will be expected. The design team will also need to clarify with the children at what stages they will be contributing, and how these contributions will be transformed into fuller production. The use of terminology that children do not understand could alienate them from the process before it has even properly begun. It is important to both provide opportunities for creativity, and to manage expectations so participants have the freedom to innovate but understand the constraints within which they can operate.

Designers of new technology wishing to involve teachers and students as participants in future developments should:

recruit a partner school at the very earliest, conceptual stages of a project to define an area for development

work with teachers and students simultaneously but separately to define problems in practice in the specific subject-related area

describe the production process and how teacher and student inputs will be used in an iterative development schedule

carefully select materials for low-tech prototyping that will allow both children and adults to express their ideas

always be totally clear about design decisions made after informant participation, and demonstrate how the informants' ideas have been made real.

3.2 For teachers

The role of the teacher in the design of new technology for education is often neglected. Most participative design practices, from usability testing through cooperative inquiry, are conducted under laboratory conditions often outside of school. Clearly this is inappropriate when such technology is likely to be recruited by teachers into their teaching plans and mobilised according to pedagogical practice. By precluding teachers from design processes, design teams run the risk of developing technology that falls outside of pedagogical, or even curricular requirements. In fact, the new DfES E-learning Strategy document (2003) highlights the importance of teacher involvement in the design of new technology. Teachers, after all, spend a great deal of time designing and producing low-tech resources for use in classrooms already. They organise, transform and present data in ways which are manageable and contextual enough for students to understand and which can scaffold for them entry to more complex information and knowledge.

Again, informant design practices have included teaching staff, particularly in the early stages of defining the limitations of existing approaches to specific subject-related topics and problems. In the later low-tech prototyping sessions, working in groups with children alongside designers, teachers can gain the added benefit of understanding how children conceive of technology from their informal out-of-school uses of it. In these respects, we can begin to see teachers, as well as their students, as 'producers' of technology, not just 'consumers'.

To add to this, such informant design methodologies can be seen to be more inclusive than long-term design partnerships. Whereas design partnerships develop over many months and extend into years, informant design is occasional and can include a larger number of participants. Design partnerships depend on good interrelationships between a small number of participants in an open process of creativity and innovation outside of school. Informant design, on the other hand, is geared towards establishing specific connections between curricular and pedagogical issues which might even appropriately be explored within a classroom or lesson-based context. From this perspective, it is clear that teachers have much to offer and much to gain from informing a design project.

Teachers wishing to involve themselves and their students in informant design of new technologies should:

- advertise willingness to be involved as a school site through public electronic mailing lists available on the Becta website
- plan activities with design partner, based on joint understandings of what each group can contribute to the design process, eg teacher defines problem area and existing solutions; students define problems with existing solutions; teachers, students and designers work together on low-tech solutions; designers develop as high-tech prototypes for subsequent usability testing with children and teachers
- contribute the pedagogical 'wrapping' into which the new technology fits, allowing it to be re-used by other staff within a curricular framework.

CONCLUSIONS

This document has outlined a variety of participative design processes, and described the practicalities of implementing an iterative informant design methodology. This approach, we suggest, is open enough to allow for creativity, appropriate for exploring specific subject-related issues, employs children in ways which accord with their skills, and recruits teachers as active participants. Clearly, any child-centred or learner-centred design approach, employed in a variety of ways and in accordance with a selection of the methods described, must be organised to meet with the needs of learners, and with the staff who will include the resulting technology in their pedagogical practices, rather than to meet commercial development requirements.

Some caution must be advised, however. Working with children in the design process, whether they are employed as beta testers, informants, or active partners, should not be regarded as a simple way of informing a design project. Adult participation can easily lead to adult domination of discussions. Some adults feel uncomfortable working on low-tech prototypes with materials that are more commonly associated with children's activities, and some children feel uncomfortable with practices more commonly associated with adult methods. Macauley (1996) states that whilst co-operation between design participants can enrich the process, the interactions between them and their different motivations and expertise can lead to chaos unless appropriately managed.

The core virtues of such approaches are, however, manifold. Widening children's participation in a democratic process of product development is not only empowering, and nor does it only contribute to better, more appropriate design. It also highlights and harnesses children's perceptiveness and creativity, and, through iteration, fosters forms of reflection on design and content. These are usually absent when children are simply provided with tools, materials and resources designed for them by commercially-motivated adult groups.

In many of the methods described, children are also engaged in authentic tasks. Working at the beginning within the parameters of their past experiences, they are gradually introduced to, and discover for themselves, other potentialities for the design of new technology. This can lead to forms of learning within the context of the design activities themselves. Though children cannot be expected to contribute their expertise at all stages or during all activities in a learner-centred design process, their participation and dialogue with each other and with the adult team members enables them to reflect on experienced practices with content in many shapes and delivered on different platforms, and to tackle problems in new and fresh ways. Utilising these practices, therefore, allows the adult design group to reflect on their own assumptions and make design alterations that reflect the input of the children and the adult participants as a working group of co-creators.

The crucial component for successful learner-centred design practice is ensuring that the adult participants, as well as the children, perceive themselves as learners in the process of designing new technology. By breaking down the distinction between adult 'expert' and child 'user', learner-centred design can provide innovative solutions to educational problems, and in the process engage all parties in the active construction of knowledge.

BIBLIOGRAPHY

Antle, A (2003) 'Case study: the design of CBC4Kids' StoryBuilder', Proceedings of the Interaction Design and Children 2003 Conference, New York: ACM Press, 59-68

Bannon, LJ (1990) 'A pilgrim's progress: from cognitive science to cooperative design', AI & Society, 4.4, Fall issue, 1990, 259-275

Bjerknes, G, Ehn, P and Kyng, M (1987) Computers and Democracy: a Scandinavian Challenge, Aldershot: Alebury

Bjerkness, G and Bratteteig, T (1995) 'User participation and democracy: a discussion of Scandinavian research on system development', Scandinavian Journal of Information Systems, vol 7, no 1, April 1995, 73-98

Bødker, S (2000) 'Scenarios in user-centred design - setting the stage for reflection and action', Interacting with Computers, 13, 61-75

Branton, A (2003) 'Developing a child-centred design process', GuardianUnlimited Online, 13 June 2003. Document URL: education.guardian.co.uk/elearning/story/0,10577,976205,00.html (viewed 11/08/03)

Brown, AL and Palincsar, AS (1989) 'Guided, co-operative learning and individual knowledge acquisition', in L Resnick (Ed), Knowing, Learning and Instruction (21-34), New

York: Lawrence Erlbaum

Buckingham and Scanlon (2003)

DfES (2003) E-learning Strategy

Druin, A (1999) 'Cooperative inquiry: developing new technologies for children with children', Proceedings of ACM CHI 99 Conference on Human Factors in Computing Systems, 223-230

Druin, A (2002) 'The role of children in the design of new technology', Behaviour and Information Technology, vol 21, no 1, 1-25

Druin, A and Fast, K (2002) 'The child as learner, critic, inventor, and technology design partner: an analysis of three years of Swedish student journals', The International Journal for Technology and Design Education, vol 12, no 3, 189-213

Eisenberg, M, Eisenberg, A, Hendrix, S, Blauvelt, G, Butter, D, Garcia, J, Lewis, R and Nielsen, T (2003) 'As we may print: new directions in output devices and computational crafts for children', Small Users - Big Ideas: Proceedings of Interaction Design and Children 2003 conference, New York: ACM Press, 31-39

Feenberg, A (1999) Questioning Technology, London & New York: Routledge

Gee, JP (2003) What Videogames Have to Teach us About Learning and Literacy, New York & Houndmills: Palgrave Macmillan

Gould, JD and Lewis, C (1985) 'Designing for usability: key principles and what designers think', Communications of the ACM, vol 28, no 3, 300-311

Just Kid Inc (2002) An Environmental Scan of Children's Interactive Media from 2000 to 2002: An Executive Summary prepared for the Markle Foundation, June 2002. Document URL: (viewed 07/08/03)

Kafai, Y (2001) 'The educational potential of electronic games: from games-to-teach to games-to-learn', Playing by the Rules, Cultural Policy Center, University of Chicago

Kafai, Y (2003) 'Children designing software for children: what can we learn?' Small Users - Big Ideas: Proceedings of Interaction Design and Children 2003 conference, New York: ACM Press, 11-12

Knudtzon, K, Druin, A, Kaplan, N, Summers, K, Chisik, Y, Kulkarni, R, Moulthrop, S, Weeks, H and Bederson, B (2003) 'Starting an intergenerational design team: a case study', Proceedings of the Interaction Design and Children 2003 conference, New York: ACM Press, 51-58

Kujala, S (2003) 'User involvement: a review of the benefits and challenges', Behaviour and Information Technology, vol 22, no 1, 1-16

Landauer, TK (1995) The Trouble with Computers, Cambridge, MA: MIT Press

Lave, J and Wegner, E (1991) Situated Learning: Legitimate Peripheral Participation, Cambridge, England: Cambridge University Press

Macauley, L (1996) 'Requirements for requirements engineering techniques', Proceedings of the Second International Conference on Requirements Engineering (ICRE 96), Silver Spring, MD: IEEE Computer Society Press

Markopoulos, P and Bekker, M (2003) 'On the assessment of usability testing methods for children', Interacting with Computers, 15, 227-243

Moldaschl, MF and Brödner, P (2002) 'A reflexive methodology of intervention', in P Docherty, J Forslin and R Shani (eds) Creating Sustainable Work Systems: Emerging Perspectives and Practices, London et al: Routledge, 180-190. Document URL: www.tu-chemnitz.de/wirtschaft/bwl9/NAR/ (viewed 29/07/03)

Papert, S (1980) Mindstorms: Children, Computers and Powerful Ideas, New York: Basic Books

Piaget, J (1951) Play, Dreams, and Imitation in Childhood, New York: WW Norton

Prensky, M (2001) Digital Game-Based Learning, New York: McGraw-Hill

Rogoff, B (1990) Apprenticeship in Thinking: Cognitive Development in Social Context, New York: Oxford University Press

Scaife, M, Rogers, Y, Aldrich, F and Davies, M (1997) 'Designing for or designing with? Informant design for interactive learning environments', Proceedings of ACM CHI 97 Conference on Human Factors in Computing Systems, 343-350

Schuler, D and Mamioka, A (1993) Participatory Design: Principles and Practices, Hillsdale, NJ: Lawrence Earlbaum

Soloway, E and Pryor, A (1996) 'The next generation in human-computer interaction', Communications of the ACM, vol 39, no 4, 16-18

Webb, BR (1996) 'The role of users in interactive systems design: when computers are theatre, do we want the audience to write the script?' Behaviour and Information Technology, vol 15, no 2, 76-83

Wiklund, M (1994) 'Usability in practice' (editorial), How Companies Develop User-Friendly Products, London: Academic Press

Wood, D, Bruner, JS and Ross, G (1976). 'The role of tutoring in problem solving', Journal of Child Psychology and Psychiatry, 17.2, 89-100