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Technology to support parental engagement in elementary education: Lessons learned from the UK

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ABSTRACT

This paper compares and contrasts two projects in order to better understand the complex issues surrounding the use of technology to support parental involvement with schools and their children's learning. The Becta-funded ICT Test Bed evaluation (2002–2006) had the intention of saturating schools (in three areas of social deprivation) with a range of technologies, including 23 elementary schools. The ESRC/EPSRC/DTI-funded Homework project (2003–2006) used participatory design methods to develop and evaluate technology to link home and school in a elementary school in the South East. Both projects shared a common theoretical foundation, that of socio-cultural theory. The theory influenced the evaluation methodology employed in both projects and in the Homework project it additionally influenced the design of the technology intervention. Findings suggest that technologies with readily accessible and interactive resources that are flexible can help develop parental engagement. However, simpler and less resource hungry solutions such as the use of websites and email can provide opportunities for quick wins. In relation to transporting technology between home and school, there are issues for both staff and parents. Without purposeful use, these challenges act as a barrier once they outweigh the novelty effect. We conclude that parental needs are complex and that engagement needs to be sensitively scaffolded rather than focussing on the technology. Participatory design offers an effective means of addressing this and should be the starting point. The technology should facilitate independence and mediate access to a shared space for collaborative activity. The content and guidance needs to be purposeful and relevant, offering a means to integrate learning across the learner's broader context, including school and home seamlessly.

1. Introduction

A historical perspective on the technology initiatives to engage parents (and carers[1]) in their children's education reveals a considerable amount of effort but little evidence of impact. The latest UK Government Home Access Initiative (Becta, 2008a) illustrates the importance that policy makers award to parents' involvement in their children's education. It also illustrates the need for us to develop knowledge and understanding of the best ways to achieve this. In this paper we discuss two initiatives that explored the use of technology to support home–school links and parental engagement.

The ICT Test Bed evaluation (Somekh et al., 2007) was a large-scale implementation in which home-community links was one of five themes. Three clusters of schools (23 elementary, 5 secondary) in areas of socio-economic deprivation were provided with substantial funding (£34 million across all participating institutions) to explore the implementation issues and potential benefits of saturating schools with technology. The length of the project (4 years) enabled issues such as sustainability of initiatives to be explored more fully than within short-term research projects. However, the enormity of the initiative meant that the research design could not support extensive data collection in relation to particular aspects; rather the qualitative strand of the evaluation which we draw on here focussed on a number of short studies intended to represent the issues which were perceived to be of greatest interest for policy makers and practitioners.

The Homework project used participatory human-centred design methods (Luckin et al., 2006) to develop an interactive Maths education system for children aged 5–7 years. The Homework project was more tightly focussed and developed at a much lower cost (700 K), and

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[1] Where we use the term 'parent' or 'parental' we are including all parents and carers.

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implemented in one elementary school. The interactive solution used a combination of interactive whiteboards, tablet PC's and bespoke software. Children who took part in the study were each provided with a tablet PC together with resources (video and interactive media, much of which was drawn from the Number Crew television programmes) for home use to support classroom activities. The system was developed iteratively with interleaved phases of evaluation and system building. The final two phases of this design process that are the focus of attention here involved a class of children and their teacher using the system at school and at home over one 4-week period and one 2-week period, respectively. The project was intensive, both in terms of levels of support and the richness of the data collected (diaries, observations, interviews, software logs). The approach is an interesting contrast to the ICT Test Bed evaluation.

We argue that combining the two projects enables us to draw upon evidence from the evaluation of a wide range of approaches. These approaches include laptops with off-the-shelf content, tablets with parental guidance and customised content for home and school use, internet access, parental training, school websites and learning platforms. This paper will describe these different approaches. We will then identify the impact together with the challenges such initiatives face, drawing on the differing perspectives of managers, teachers, parents and learners. Finally, we will draw out the implications of our combined findings in relation to future directions for policy and practice.

2. Parental engagement in learning and the role of technology

Parental involvement in schooling includes communicating between school and home, supporting learning at home, and participating in school life from helping in classrooms to decision making through governance structures (Epstein, 2001). Effective parental involvement is believed to have a positive impact on a range of pupil-related outcomes (Epstein, 2001; Hallgarten, 2000). The promotion of greater parental involvement has been high on the UK Government agenda since 1997 with the introduction of home-school contracts and an intention to build stronger relationships (DfEE, 1997a). At the same time, the New Labour Government launched a major programme of investment in technology for schools through the National Grid for Learning initiative (DfEE, 1997b, 1998) aiming to connect all schools to the internet. Furthermore, there was increasing interest in the potential for ICT to overcome social disadvantage through equipping homes with technology and providing access to a range of educational resources (DfES, 2002; Hallgarten, 2000).

The potential of linking home and school through technology, for example through laptop and PDA schemes, became more apparent (Somekh, Mavers, & Lewin, 2001):

- To transform the role and status of homework, and extend opportunities for learning.
- To transfer work between home and school, and access school intranets and learning platforms anywhere, anytime.
- To improve communication between school and home.
- To improve attainment through increased parental engagement.

To underpin the policy directives, the UK Government and associated agencies have continued to commission research on the links between parental involvement and pupil outcomes, as well as monitoring the extent of parental involvement in schooling (Peters, Seeds, Goldstein, & Coleman, 2008). Desforges and Abouchaar concluded (2003) that *spontaneous* parental involvement does lead to increased attainment but that the evidence from studies of *interventions* to develop parental intervention further was inconclusive with regards to impact on attainment. Harris and Goodall (2008) conclude that home-based, rather than school-based, involvement in supporting learning has the greatest impact and that schools need to provide "guidance and support which enable such engagement to take place" (p. 286). From the perspective of parents, in a recent survey 82% indicated that they would still like to be better informed about their children's education (Byron, 2009) despite the initiatives to date.

Some 10 years on, policy directives continue to stress the need to 'involve parents fully in their children's learning' (p. 3, DCSF, 2007). Moreover, policy makers still refer to the potential impact of linking home and school through technology (Becta, 2008a; DCSF, 2007; DfES, 2005) but despite continued investment and research only limited progress has been made (Somekh et al., 2007). Much research highlights success stories but there is a tendency for these to be highly dependent on funding and support (Kerawalla & Crook, 2005). In addition, it is argued that parents and carers lack sufficient ICT skills and knowledge about how to support children's learning through ICT (ibid). As such there is little evidence of the impact of technology to support parental engagement; the potential has yet to be realised.

Home access to a computer and the internet for 7–11 years olds is now believed to be around 90% (Becta, 2008a; Cranmer, Potter, & Selwyn, 2008). To ensure universal access, building on knowledge acquired through ICT Test Bed and Computers for Pupils, Becta, the UK Government agency for technology throughout learning, has launched the Home Access initiative. This is designed to ensure that the most disadvantaged children (aged 7–16) are able to access computers and the internet in their homes (Becta, 2008a). But access does not guarantee use, and moreover does not necessarily lead to educational use (whether for formal or informal learning).In addition to the provision of hardware in the Home Access initiative, support will be put in place to ensure that parental engagement is developed further (Becta, 2008b, 2008c). The nature of such support is as yet unclear, but as the focus appears to be on online reporting to parents it seems that support may be limited and targeted. There is a need to continue to investigate ways in which technology could support and enhance parental engagement more fully.

3. Theoretical grounding

A broadly socio-cultural framework underpinned the qualitative research in the ICT Test Bed project, drawing on Vygotsky's notion of cultural tools shaping human capabilities (Vygotsky, 1978) and a post-Vygotskian analysis of human activity (e.g. Wertsch, 1998). Developing an understanding of the affordances or latent possibilities of digital technologies in education systems can lead to new and powerful forms of activity. In this context the theoretical framework has influenced the analytical methodology selected and provided the lens through which the data have been interpreted.

The evaluation component of the Homework project drew on socio-cultural theory in a similar way. However, the theory also informed the development component, underpinning the design process. The pedagogical framework for the Homework project was based upon the concept of a Broadband Learner Model, defined as a learner model created through the use of technology to link a learner's educational

experience across time and context. The term 'Broadband' was used to highlight our ability to capture a growing bandwidth of information about learner experiences through increasingly mobile and pervasive technology. The term 'context' here includes the location of use and the resources available to the learner in that location: both human and artifact. The Broadband Learner Model framework was informed by Vygotksy's Zone of Proximal Development (Vygotsky, 1978; Vygotsky, 1986) and had been refined through previous technology design projects (see for example Luckin & du Boulay, 1999, 2001).

4. Two models for home/family/parent engagement in UK elementary schools

4.1. The ICT Test Bed project

The ICT Test Bed evaluation (Somekh et al., 2007) involved 28 schools, of which 23 were elementary schools, and 3 colleges of further education, organised as three separate clusters. Supported by the three local authorities, the institutions initially focussed on the themes of teaching and learning, and leadership and management as they were most closely related to the core business of education. The initial implementation phase included technologies in all classrooms (interactive whiteboards, data projectors, visualisers, graphics tablets) and management information systems.

As the schools turned their attention to exploring the impact of technologies on home-community links, the three clusters (and individual schools) experimented with a range of approaches. One of the aims of this strand of the project was to increase parental engagement, providing parents with access to information about their child's homework, progress, attendance and behaviour. In ICT Test Bed, using ICT to support home-school links was the aspect that was least developed by the end of the project. This was hardly surprising given the need to focus initially on teaching and learning in the classroom (the immediate context).

One cluster decided to provide a computer for every home together with internet provision. Approximately 1600 machines were distributed and about half of the homes were eventually provided with internet access. One of the seven elementary schools implemented a learning platform before the others and purchased educational content from the same provider for the learners to access at home. The learners were not, however, directed to use this content for homework. The learners noted that they used the resources occasionally at home for fun. Towards the end of the project the remaining schools in this cluster also introduced a learning platform. One teacher from a elementary school regularly set homework online, printing off the activities for the small number of pupils in her class who did not have home internet access. For example, for science homework pupils were presented with an image of a flower and answered multiple choice questions on male and female parts. This was auto-marked so that the pupils obtained feedback immediately. Pupils were also able to comment in the self-evaluation box, identifying topics that they found easy, challenging and hard using a simple traffic light system. This enabled the teacher to identify topics that needed revisiting prior to the national assessments.

In this cluster, parents were provided with information about the learning platform and courses when they collected the computer. They could also attend one-to-one training on how to use the learning platform, could access 'learning zones' in local community centres for parents without internet access at home, attend road shows and drop-in sessions, and read booklets and guides. The learning platform provided access to skills for life training resources such as English for speakers of other languages courses from the National Institute of Adult Continuing Education and other direct links, for example local job centre vacancies. With regards to involvement in their children's education, the learning platform (tailored for each school) offered general news, school newsletters and other school information, information about individual children, and an easy means of communicating with the school. In one of the elementary schools the learning platform was used to showcase pupils work and show photos of events. At least two parents accessed the learning platform in this school regularly (although one was a member of staff at a neighbouring school which also participated in ICT Test Bed). One pupil who went to India for 6 weeks to visit family uploaded photos into the learning platform to share with the class, as well as work for his teacher.

In the second cluster two elementary schools (an infant and a junior feeder school) which were linked with a secondary school also undertook a similar project but on a smaller scale and with no attempt to provide connectivity. This cluster included three secondary schools and the scale of providing home access and connectivity proved impossible to finance. In the third cluster there was a greater emphasis on laptop loan schemes in the participating elementary schools, partly because it served a rural area with less developed infrastructure. This was managed on a school-by-school basis. In one school for example, all pupils in years 5 (aged 9–10 years) and 6 (aged 10–11 years) were allocated a laptop for their personal use.

A number of schools across the three clusters also invested in community drop-in centres both to provide access to the internet and to host a range of training courses for parents and others. Schools also invested in mobile technologies such as digital cameras which in some cases were sent home with children to capture images from outside school, providing a focus for discussion. In order to better support home-school communication, many schools invested in technical staff to develop and maintain school websites. In addition, the management information systems facilitated remote access by parents (offering access to attendance, attainment and behaviour information) and this was introduced in a number of schools, although largely towards the end of the project. Some schools developed email use between school and home, and one or two experimented with text messaging.

4.2. The Homework project

The Homework project was an intervention study that involved teachers, parents (and carers) and children in the development of an exemplar system to test out the Broadband Learner Model (BLM) framework to ground an adaptive, interactive Maths education system for children aged 5–7 years in school and at home. The BLM framework is based upon the belief that any system designed to support learning (whether human, technical or a combination of both) needs to have four types of knowledge provided by four system components as briefly described in Table 1 with more detail available in Luckin et al. (2006).

The participatory human-centred design approach ensured that the technology developed was not only useful and usable but also well suited to the context of use. This approach also contributes to the sustainability of a project beyond the product itself through ensuring that a community of users and beneficiaries develop the knowledge and skills to formulate views about the design of technologies and become more discerning users. The design process started with a scenario-based system vision of the perceived opportunity for technology to sup-

Table 1
The Broadband Learner Model.

Knowledge type	System component
Knowledge of the learner	Broadband Learner Model: with dynamic, updateable, collaboratively constructed profiles of individuals and groups. Accessible from multiple devices and across multiple contexts
Knowledge of the domain of available educational resources	Content management and coherence compilation: a store of tagged (dynamic and static) rich media with specification of the relationships between these content elements. Metadata tags needs driven by and compatible with the elements in the user model so that learners can be matched to relevant resources (Tunley, du Boulay, Luckin, Holmberg, & Underwood, 2005). Mechanisms to locate, match and compile resources into intelligent lesson plans (Luckin, Underwood, du Boulay, Holmberg, & Tunley, 2004)
Knowledge about pedagogy and scaffolding	Scaffolder: used to specify the way the resources are described, the design of the learner profiles and the way in which resources are combined into learning activities
Knowledge about how to support collaboration	Collaborator: learner profiles are collaboratively constructed between learner, teacher, parent and system. The way the resources and learners are described and the way resources are combined into learning activities or lesson plans promote collaborative learning

port and improve learning. This vision was grounded in both the BLM theoretical framework and the prior experience of the designers. Through the ensuing development process the system users and beneficiaries were involved in a process of modifying and validating this vision in a cyclic process of vision communication and revision. This process started with the use of scenarios, storyboards, and lo-tech prototypes with focus groups, workshops, interviews, and in situ evaluations. The system vision evolved through the cyclic design process and became increasingly grounded in the users' needs and setting, and increasingly represented in hi-fidelity and functional prototypes and associated documentation.

As highlighted by other authors (Scaife, Rogers, Aldrich, & Davies, 1997, for example), working with children as designers is challenging. Their reaction and engagement in activities is hard to predict and flexibility is required to ensure that the process can be adapted to enable children to express themselves effectively. Teachers and parents too can find design hard. They often feel that they lack the technical skills required and need to be offered access to the process through a balance of the familiar and the new. In the Homework project we iterated through six design phases and engaged participants in a variety of activities that led to an increasingly detailed design specification and an increasingly sophisticated prototype. Table 2 summarises one of these design phases as an example (the full details of which can be found in Luckin et al., 2006).

The system that was developed in the Homework project through this iterative process was an interactive Maths education system for children aged 5–7 years that consisted of lesson planning, control and home use components. The system contained a rich set of multimedia and associated interactive numeracy resources. The Homework design process indicated that teachers, parents and learners had a set of identifiable needs:

Teachers needed a system that included activity planning, classroom monitoring, a way to set homework activities and to automatically receive completed homework, and a communication mechanism with parents. These requirements were provided in the Homework software through tools to support:

1. Lesson planning that included a resource browser, editable pre-existing lesson plans and new plans, the capability to decide where each resource should be displayed, i.e. on the interactive whiteboard or on children's tablets as a group, a whole class or individually.
2. Classroom management that included being able to start and stop lesson elements, send messages to children and monitor their activities.
3. Homework feedback, marking and communication with parents. These included enabling the teacher to view the latest outside school tablet activity and a history of each child's entire tablet activity both within and beyond the classroom.

Children needed personalised and adaptive activities with immediate feedback that they could complete as part of a class, a small group or an individual. The activities for home needed to be presented in a manner that made them relevant to the setting and that encouraged parental engagement. The child also needed the ability to share and discuss with their parents and family the activities they had completed at school. These requirements were provided in the Homework software through:

1. Entertaining 1:1 multimedia teaching and self paced learning activities with immediate feedback.
2. Activities specifically designed to be completed in the home that tackled the same objectives as those completed in class.
3. The option to review class work at home, try again, and to share these with their family.
4. Fun activities that were not specifically homework but that were related to curriculum goals, some of these were specifically designed to be done collaboratively, with other family members for example.
5. New style non-paper-based homework tasks.

Table 2
The phases in the Homework project development.

PHASE 2 Activity and Aims: Improve understanding of home context and home users needs. Home context, parent engagement, explore current homework patterns, current home technology, location and use, assess family availability and attitudes to tablet activities in the home and related technology attitudes			
Method and duration	Tools	Data	Outputs
Diary study with 37 parents/carers to record homework activity and enthusiasm every half hour. Parent interviews with 12 families	Diaries. interview script, laptop with PowerPoint scenario	Digital voice recordings and completed diary sheets	Findings: homework activities need to be flexible and designed for use in first hour after children return from school. Parents want to know what child has done at school. A modified system vision and enhanced home storyboard integrated with classroom

Parents needed an increased understanding about what their child was doing at school and a focus to support conversations with their child about school activities. They needed to know how Maths was being taught and what they could do both formally and informally at home that would be relevant to current Math's learning objectives and a means of communicating with the teacher. These requirements were provided in the software developed in the Homework project through:

1. A custom designed Home interface that automatically appeared when the tablet was switched on outside the area of the classroom network. This interface provided access for child and parent to the activities the child had done at school, the activities to be done for homework; a store of all the activities the child had completed with the tablet in any location and some fun activities and games.
2. A messaging system that parents could use to communicate with the teacher.
3. Information specifically designed for parents and associated with all activities that indicated the objective of the activity, the vocabulary being used and suggestions for relevant home based activities.

These user needs formed the user requirements for the system development in the Homework project.

5. Lessons learned from the ICT Test Bed and Homework projects

5.1. How was parental engagement in learning supported?

In ICT Test Bed, providing access from home to a range of supporting resources for parents and their children was achieved in a variety of ways from learning platforms to simple, yet effective, uses of school websites. As described above, in one elementary school, learners were being set homework via the learning platform. In another cluster all but one of the six elementary schools were using the website to support literacy and numeracy development at home, providing weekly: spellings, homework sheets, planning and parental guidance. This information was uploaded by teaching assistants. At least two of these schools were still engaging in similar practices some 3 years later (in 2009). Although there are no data regarding how these resources were and are used by parents, we would argue that since the practice still exists staff must perceive that it is beneficial. An example relating to English for Year 1 children is presented in Table 3.

In phase 5 of the Homework project a class of 30 children and their families acted as participants for 4 weeks, in phase six 32 children and their families were involved for 2 weeks. Across both these phases, the tablet PCs were used at home for an average session length of 31 min (phase 5) and 25 min (phase 6). The most common time for the tablet to be used was weekday evenings followed in popularity by straight after school in phase 5, and during the day at weekends followed by straight after school in phase 6. The system was most often used at a table located in a communal space such as a lounge, dining room or kitchen, followed by the bedroom and infrequently in a car or somewhere else. The most popular types of activity at home were the fun activities, the homework and watching the Number Crew videos. The data from the diaries maintained by parents offers useful information about who engaged with helping learners at home. Mum was the person who most frequently helped with the homework activities with 48% of the recorded engagements attributable to her, 27% were attributed to Dad, 12% to siblings, 7% to other family members and 6% to friends.

When the Homework project tablet PC was out of range of the classroom network families were presented with a single main interface that enabled them to select from five options: review what the child had done with the tablet at school, review what the child had done in total (i.e. inside and outside school), see the activities set for homework, access curriculum relevant fun activities, send/receive a message to the teacher. Each activity page also contained a 'Grown-ups' button. When this was selected for a particular activity, information about the activity and it's purpose along with suggestions for how to help were provided as illustrated in Fig. 1.

The multiple data sources were also combined to form case studies about individual children and their families. For example, the following short extract from a case study of one learner offers brief insight into the types of activity learners completed. Alison is 6 years old in 2005, she and her two sisters Catherine and Elizabeth live with Mum and Dad.

> ... Once again the Homework [project] Tablets come home for the weekend on 29 April. Alison has friends visiting and on Saturday afternoon she shows them her Homework Tablet. She shows them some of the videos, games and exercises. They open up the camera, play InkBall,[2] and write in Windows Journal. Later that same day at about 6.50 pm Alison and Dad use the camera in the garden. Alison also spends 3–4 min completing some Number Crew Calculations, watching a Number Crew video and opening her completed Skill 5 homework activity. ... Later this evening at around 8.15 pm Alison does one of the homework activities in her bedroom on the bed with Dad. Alison does the 'Ten thing Bowling'[3] Activity Alison then does level 2 of the Skill 5 homework activity for about 5 min and finishes this session by watching some Number Crew videos with Dad. ...

Narratives such as this provide interesting information and illustrate that Alison makes use of the flexibility offered by the technology and uses her Homework project tablet PC in a variety of locations and with a range of different people. Sometimes she works on an activity for a minute or two and on other occasions for much longer. She is able to choose what she wants to work on, she can show it to her friends and other family members and in so doing behave independently. The whole family get involved in a way that fits with family life.

5.2. Implementation issues

In terms of the provision of technology and connectivity in homes in ICT Test Bed, not surprisingly the lack of funding was a huge constraint. The general trend towards mobile telephones rather than landlines made it difficult initially to orchestrate cluster wide internet provision, although this challenge was eventually overcome. The scale of implementation for a whole cluster of schools was a mammoth task, leading to long delays and placing additional burdens on teaching and admin staff. In the cluster which offered home ownership for one secondary, and its feeder junior and infant schools, the different institutional agendas and requirements caused additional tensions.

[2] A game that was part of the windows OS package.
[3] This was an interactive activity about counting to 10 extracted from the number crew television programme material.

Table 3
Parental guidance for year 1 English w/b 23.03.09 (ICT Test Bed).

Year 1 weekly planning	Term: spring date: 23.03.09	How can you help at home
English	Spellings – **your, will, next, after** Handwriting – words with **ai** and **ay** Reading – to share a story **Rumble in the jungle** To introduce the story poem To be able to role play a poem To identify rhyming words	Please practice spellings and read each evening Ask your child to retell the story **rumble in the jungle**

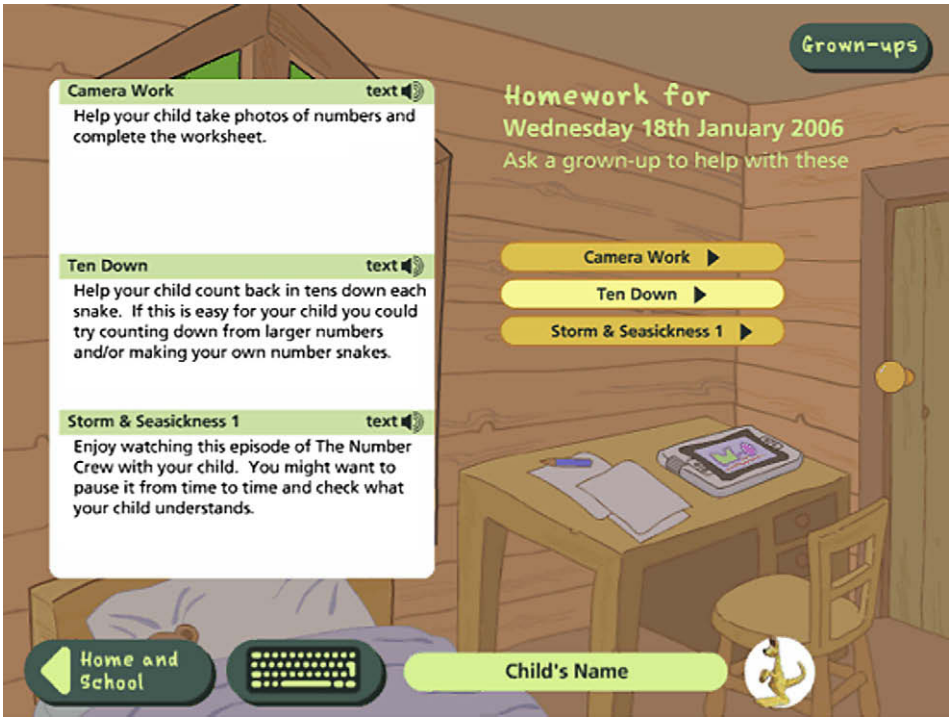

Fig. 1. Homework activity with grown-ups button selected (The Homework project).

Barriers to parental take-up of home computers for their children included concerns about safety and costs (although there were none), being monitored in the home and the growth of mobile telephony replacing landlines. Parents' lack of ICT skills and confidence was also perceived to be a barrier (also identified in Cranmer's study in 2006) as were technical faults, losing passwords and language barriers. Teaching staff intended to address skills and confidence through training and courses but of course this relied on parental attendance. A perceived successful strategy in relation to parental support for this initiative was to identify and employ 'learning champions'. In the ICT Test Bed project three were appointed in one of the clusters, two of whom were parents. These champions talked to parents when they came to collect their computer from schools or in the library or at the school gates, dealt with problems, encouraged parents to enrol on courses and visit schools.

The development of resources for the learning platform (for elementary and secondary schools) in one cluster was supported by a content development team who worked closely with teaching staff. Therefore the pedagogic skills of teachers were complemented by the technical expertise of the onsite development team. The learning platform was used to provide general information to parents in elementary schools but accessing attainment data was not enabled at the time of this study.

In contrast, the system used in the Homework project was a research prototype and constantly under development. This led to some practical implementation difficulties. For example, there were some teething troubles with the classroom network and the speed of data transmission to tablets once the lesson plans had been constructed. This meant that in the 2006 study the teacher when interviewed was positive about the system, however, she also reported that she had found the lesson less smooth running than she would have liked and that the technical difficulties and setup time seemed to be great to her.

There were no problems associated with internet access to families in the Homework project, because the system did not require internet access outside the classroom. The tablet's were 'charged' and updated with learning resources each time they were in range of the classroom server, resources that were designed to be released on certain days. Likewise the data on the tablets about what had been done with them whilst outside the classroom was pulled onto the classroom server when the tablets returned into range. This had not been the original design vision, but concerns amongst parents about being able to distinguish their child's individual progress in collaborative peer work, and safety led to this design decision.

5.3. Management issues between in and out of school for laptops and other technologies

5.3.1. Collecting and returning the laptops

Some parents of children at ICT Test Bed schools did not bring back laptops fully charged despite signing an agreement to do so. The teacher at one school eventually got a classroom assistant to manage the laptops in and out of school. Similar issues were faced in the Homework project. When Tablet PCs came back into the classroom they needed to be placed into a storage trolley that also charged their batteries. This was a fiddly and time-consuming task. Parents in ICT Test Bed also expressed concerns about children being attacked on way home from school and staff were concerned about theft and damage. However, fears about security issues and damage were largely unfounded although there were a small number of incidents:

> "We haven't had any problems with the laptops going home apart from one screen being shattered in 18 months. Which we think would've been a parent but no one admitted too. I was very sceptical at the beginning when we had all the parents in and they were signing all the forms, I thought that there was going to be endless problems. But there hasn't been."
> (elementary school project manager, ICT Test Bed)

In one cluster about four computers were stolen, despite a deliberate decision to make the machines low specification and therefore less attractive. In two schools parents began to complain about carrying them home due to the weight of the laptops. Many already had computers at home and just wanted access to the educational software which had been installed on the laptop.

5.3.2. Technical issues

In ICT Test Bed there were issues relating to lack of support at home, particularly with getting software to work. However, not all parents attended the training that was provided. The virus checker that was provided in one cluster was not updated, leading to some problems. Battery life was also seen to be an issue by staff. In the Homework project it was clear that a system for simultaneous use by 32 5/6 years olds needs to be extremely robust and responsive as does the hardware. Common problems experienced by users in this project related to the usability of the tablet PCs, for example bad pen tracking, slow start-up, irresponsiveness, poor camera usability, pen battery life and small text. However, this is unsurprising given that the hardware and software were prototypes in development.

5.4. Evidence of impact: parental involvement, family learning, increased communication

5.4.1. Parental involvement

Short-term laptop loans in elementary schools in ICT Test Bed brought parents in regularly initially but in many schools commitment waned and it was difficult to sustain this type of initiative. This could have been due to perceptions of the lack of purposeful use and perhaps losing the novelty element:

> "if they are taking laptops home they have got to have something to do on those laptops that are worth doing. That in itself, you have got to make sure that they have got that, so it is quite difficult."
> (elementary school project manager, ICT Test Bed)

Although no data were collected to explore the impact of the information provided via school websites in one cluster, as the schools still offer this form of support staff must perceive that it is beneficial for some. In comparison, in the Homework project, the content was closely linked to classroom activities and it was very clear what additional work learners could undertake. In addition, as the tablets did not go home every day (partly due to the logistical issues of managing them in and out of the classroom) and the evaluation periods were just 4 and 2 weeks, there could have been some element of novelty in their use.

In ICT Test Bed there was a tension between linking home and school electronically facilitating 'remote' engagement in school life, and a desire to get parents onto elementary school premises. One school in particular only supported access to resources and training from school premises to ensure that this occurred. More generally, in most cases families were expected to attend onsite training courses before collecting technology for home use and this was seen to be effective for some:

> "We are actually seeing a positive affect. Parents are coming in wanting to know more about the school, wanting to know more about homework, wanting to know what is available and wanting to come in for drop-in courses. We [did not have] a big uptake but we are getting a steady flow of parents coming through and want to learn about [...] the computer and beginning to realise they need to upskill themselves."
> (family liaison project manager, ICT Test Bed)

Other opportunities for bringing parents onto school premises included information dissemination events and technical support provision. However, attendance was still considered to be disappointing: "*We had a website introduction where parents [were] invited in. Only about 10 parents came*" (teacher, infant school, ICT Test Bed). The so called hard-to-reach parents remained elusive.

In the Homework project parents felt better informed about what their children were doing in school. They were provided with information about curriculum objectives (accessed in the final version via a button on the screen labelled 'grown-ups') and could see both work undertaken in school and that set for homework. Some parents (as indicated in interview and diary data) felt that the approach was less formal than helping with traditional homework:

> "I would say I've enjoyed helping more, partly because it sort of feels less formal I guess, and you don't necessarily need to be sitting at a pristine table, with everything laid out."
> "...it tells you what the learning objective is, which, for me, I thought "ooh, now I know why". There is better connection with reasons why they are doing stuff because I can find it, which I think actually comes back to being a working parent. I don't get time to come into class to ask those questions whereas the computer, I can obviously log on and find it that way."
> "The story in the Number Crew video was great and we spoke about counting on afterwards as suggested in the 'grown ups' information."

5.4.2. Family learning

The provision of technology within schools for community use did lead to some parents undertaking ICT skills training as well as other courses:

> "From what I can see they are just wowed by it – the parents don't want to be seen as learning but they are going off and wanting to learn. Really positive from what I can see as regards parents."
>
> (elementary school project manager, ICT Test Bed)

At least four elementary schools offered family learning opportunities on the school site. For example, one elementary school invested in a temporary building equipped with a suite of computers which they labelled the 'Community hub'. The school appointed a member of staff to run this initiative and offered a range of courses for parents (some together with their children) and grandparents: for example 'learning Spanish with your child' and 'family fun with computers'.

5.4.3. Communication

Technology in ICT Test Bed made it easier to share information with parents through websites and learning platforms. Some schools made increasing use of email which enabled rapid responses to parental queries as well as offering a record of communication which took place. However, the communication was, as it has been in the past before the investment in technology, predominantly one-way despite the potential for technology to more easily support two-way communication. A very small number of parents in ICT Test Bed had begun to access their children's assessment data via the MIS.

One school encouraged parents to report absence via email. However, in another school parental enquiries via email were responded to by post due to concerns. Another headteacher reported that one parent was emailing the school daily. There was a perceived need to develop protocols for email communication between school and home (in relation to workload management, authenticity, and potential ambiguity). There was evidence of increasingly sophisticated uses of school websites to support parental engagement with their children's learning (as described above), partly because technology had become easier to manage and operate. This was seen as a quick win – something that did not require too much effort but that had the potential to maximise impact. School websites were also used to disseminate information such as newsletters, letters, and calendars of events (also archived and available to download).

6. Discussion

The two projects from which we draw offer insights from two different but arguably complementary perspectives. The 'tight focus' of the Homework project offers rich data on what parents, learners and teachers want as well as how they might actually use such a system over a short period (2 and 4 weeks). The 'wide angle' of ICT Test Bed offers a clearer insight into how schools might incorporate existing technologies to support parental engagement and what could happen over extended periods of time. However, it lacks the richness of the data offered within the Homework project. We have used the challenges and issues raised by each project to revisit the data with a critical lens. What can be learnt from each and how could this inform future directions?

Both the ICT Test Bed and the Homework project demonstrate that when introduced, supported and used appropriately, technology can improve links between home and school learning and close the gap between parents, teachers and learners. However, providing technology and connectivity will not of itself lead to improved parental engagement. Parents require support and effective communication with regards to the best ways in which they can engage with their children's learning in the home. Laptop loan schemes and the provision of computers/connectivity in the home did bring parents into school. These parents included those who had previously had little contact with the schools. However, there remains a challenge of how to engage all parents universally and how to sustain such engagement.

In ICT Test Bed, there was limited evidence of how technologies were being used by parents and their children at home although many staff were enthusiastic about the potential and the early indications of positive impact. Parents who participated were perceived by teaching staff to have developed ICT skills, developed increased confidence and a greater awareness of how to support their children. One of the key lessons learned was that managing the distribution of computers and connectivity, and the associated requirement for technical support, is a major undertaking and an unreasonable additional workload for teachers and schools. This finding contributed to the development of the Home Access initiative (Becta, 2008a).

The Homework project illustrates that children enjoy having their own personal technology both in the classroom and the home, and that even young children are well able to look after and care for this resources. There is also some evidence of learning gains (Luckin, 2006). However, in order to engender parental involvement, parents need clear guidance about how to help their child and activities need to be designed in a manner that encourages collaboration. The technology needs to provide continuity across locations: the appropriate contextualization of activities across school and home contexts is a key design principle. Parents who took part in the Homework project valued information about the National Curriculum and what their child was doing at school: information that was specifically targeted at them. They also appreciated knowing more about what their child was doing at school. Increased parental involvement was linked to increased parental enjoyment of working with their child.

Inherently similar guidance to that offered within the Homework project was provided through weekly updates via the school website in some ICT Test Bed elementary schools. However, this approach requires parents to locate and access it rather than such information being easily accessible when a child is using the tablet provided in the Homework project. On the other hand it is updated weekly and covers 11 areas of the curriculum with very limited demands on resourcing.

In terms of developing links between school and home there is a need for additional resources (managers, champions with release time and/or financial incentives). The most progress was achieved in ICT Test Bed schools with enthusiastic members of staff with effective management and leadership skills driving the innovation. Similarly, the Homework project which involved a significant investment of time by developers and researchers evidences the need for additional resources.

When we brought together the findings from the two projects we identified a number of tensions. Firstly, with regards to sustainability, there was clear evidence in ICT Test Bed that short-term laptop loans were more successful than long-term initiatives. In the Homework project it is difficult to comment on the sustainability although there was anecdotal evidence that parents wanted the initiative to

continue. Alongside this was the underlying pedagogy – that of purposeful use and clear parental guidance in the Homework project as compared to limited direction and support in ICT Test Bed (although it was clearly early days). However, we would argue that tightly focussed developmental studies such as Homework, when implemented as part of a design process, can inform longer term initiatives. For example, through building capacity in homes and schools, and increasing our understanding of what parents appreciate. There is a place for both internally-driven, naturalistic studies of technology solutions and externally-driven, developmental initiatives. Further we would suggest that there is also a place for both complex, resource-hungry developments and also for exploring simple, quick win solutions.

In terms of ownership another interesting tension was apparent. In the Homework project children saw the tablet PC as their personal device. There was no reported damage or loss; the children took great care of the technology. It made the personalisation of the digital and physical resources more complete and meaningful. However, in ICT Test Bed the laptops were viewed as school property and when there appeared to be no purpose behind their provision, the interest of parents and children waned.

Interestingly, the provision of technology for home use in ICT Test Bed in many examples included connectivity whereas in the Homework project the tablet PCs were only internet enabled in school. The value of connectivity is limited unless it is accompanied by clear guidance about how to harness the potential benefits. The Homework project system operated relatively well without offering access at home. Therefore, it is worth considering the possible benefits of not always being online. There was no evidence of concern amongst parents, for example, about emails, internet safety or plagiarism, when they were using the Homework project system. Rather, parents were able to focus on helping their child learn Maths. We should avoid technological determinism and ensure that any uses are appropriate and of potential benefit.

7. Concluding remarks: next steps

Technology can help to support increased parental involvements and this is beneficial for both learners and teachers. However, the needs of parents are complex and this demands that consideration is given to:

- Carefully designed, parent focussed support.
- Understanding what parents really need in order to help them get involved.
- Recognising that activities designed for school are not necessarily transferable to the home context and vice versa.
- Ensuring that learners' and parents' uses of technology at home are purposeful.
- Avoiding technological determinism and developing mechanisms that allow the nature of the technology and the ways in which it is used to evolve alongside growing family engagement, knowledge and expertise.
- Acknowledging that the use of technology to develop working relationships between schools and families is an on-going enterprise that needs to be nurtured in order to develop sustainable solutions.
- Ensuring that continuity between in school and outside school is built, e.g. through carefully designed activities that aim to make work done at school relevant to the home context.

We conclude that the participatory design approach adopted in the Homework project was particularly powerful, not just as a means of identifying solutions which meet users needs but also to develop stakeholder engagement. By involving parents and learners from the outset they become more aware of the potential benefits, not just in relation to the technology, but also in relation to effective strategies for parental engagement in learning. What the technology offers is a means of integrating the school and home contexts ensuring that learning is interconnected. Parents can better understand what their children are doing in school (and at home) and are able to offer appropriate support and additional activities. However, for technology to be successful the purpose needs to be clear to both learners and their parents; that is activities need to be structured and parental guidance needs to be available. Technology enables learners and parents to be independent and autonomous whilst offering support and guidance when required. It also facilitates shared spaces and opportunities for collaboration, which can enrich the benefits of parental engagement.

The discussions of the Test Bed and the Homework projects demonstrate that there are clear benefits to both approaches and that there is much to be gained from combining data as we have done in this paper. The participatory approach to design provides important insights into family needs that require further development with an increasingly wide range of participants. The provision of technology to large numbers of families provides initial indicators about where the challenges and tensions are likely to occur that need to be drilled into further if successful interventions are to be developed. The overwhelming message from both projects is that developing parental involvement in children's learning with and through technology is complex and requires careful attention to sensitively targeted support.

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