One of our most important findings from this and previous research relates to the teacher's central role in supporting primary children's collaborative science learning at the IWB. As our model indicates, teachers mediate children's learning directly and indirectly: they enable the children to engage in productive talk between themselves, and they structure the IWB tasks and workspace to promote interactivity and knowledge-building. Teachers are also responsible for establishing the wider classroom ethos, procedures and working relationships that provide opportunities (and sometimes constraints) for children's active participation in learning from day to day. The quotes below are included to indicate some of the teachers' thoughts at the end of the project, with reference to our broad conclusions about the circumstances in which the IWB may provide both a tool and an environment that can encourage the creation of a productive shared dialogic space for children.

From the teachers' perspective we found that the IWB can effectively support children's collaborative learning

IF

There is active support from the teacher for collaborative dialogic activity in the classroom and the teacher devises tasks that use board affordances to promote active learning and pupil agency.

> *As the project continued, teachers often became clear about their intentions for dialogue and learning with the IWB activity:*
>
> 'It's our knowledge of the children and our knowledge of what we want them to learn, and knowing what will engage them, what will interest them and what will make them talk, because essentially the activities that we put together were designed to help facilitate discussion between those kids…I mean for me, the talk came before the science, and outcome and the learning of the science that occurred as a result of that talk was in many cases throughout the activity really really good.'
>
> 'It makes you think about how the children were learning….When (the other teacher) and I sat down and looked at our lessons and thought perhaps they wouldn't be able to do that, because of how the links were on the page, their prior learning or how they're used to working, so things had to be re-arranged. But if you were doing a paper-based activity you perhaps wouldn't have thought so much about the children's learning itself, you'd have just done a worksheet and given it out. So there was quite a lot of discussion as to how the children were going to learn from what we were producing for them.'

They could also identify effective their classroom strategies for developing children's productive talk:

'I found that if you don't have the awkward ones (items) in there the discussion's over very quickly, whereas when you throw in some things where it could be one thing, could be another….'

They had to be able to talk well in a group before they did any kind of science discussion. They had to know that reasoning and getting on with each and taking turns.'

'For me, just getting them to work in groups of three was what made the biggest difference, using that a lot more than paired work opened up a whole new area of collaborative working, with or without the board.'

Some teachers began explain what they saw as distinctive about the IWB itself:

'Obviously the learning is the most important thing, but I think that given the fact that it's an interactive whiteboard, the affordances and the way you can make it look, for me was very very important. I took that on as part of the challenge, to make the most use of the board as I possibly could. So …. the collaborative classroom ethos is very important; did the talk rules, went down that line there. But if you're not using the technical expertise, and it is just a case of a simple activity, where the children aren't necessarily going to be engaged by it, it's that engagement that it offers, as opposed to worksheets….I think the technical expertise is as important in bringing the whole package together for me, because it's a technical piece of equipment….it's the confidence to deliver and the confidence to know that what you're going to do is going to work.'

Teachers were also aware of some intrinsic motivations and enjoyment for the children in using the IWB:

'Even by the third filming they still really enjoyed just the fact of writing on the board and they all wanted to the one with the pen doing the writing.'

'I think probably the audience thing is part of it, knowing that their writing is up there and everybody could see it…almost a sense of power really, partly just being the one holding the pen and being in charge.

The importance of physical aspects of the IWB workspace became evident:

The fact that it's vertical, as opposed to horizontal, lends itself to standing up, talking, looking at an object and talking about it, a lot more than people keeping their heads down….I don't know if the term "ergonomic" fits there.'

'…the size of it I think, because a lot of things are similar on a laptop, but then you're all crowding round ….(the IWB is) nice and big and they can stretch out, have almost got their own space, although they're in a communal space. Whereas if you're on a laptop you're all squished together in a confined space.'

'For children to all be in a space that's very very small it's not as conducive to their learning and it's not as conducive for them sharing ideas as the whiteboard.'

Teachers also reflected more generally on the whole classroom environment and the responses of all the pupils:

'With the classroom environment, something that really struck me was the fact that in standard lessons the whiteboard tends to be the focus of a lot of learning that takes place. The whiteboard is where all of the children look when they need clues or when they need a cue, and it was amazing how well the whole class adapted to fact that that wasn't being used for their purpose. It wasn't there for everyone; it was there for the group that was working on it, while other groups had their independent resources. So I think it's testament …to the fact that children don't need to have sight of the IWB. They don't need to have sight of that space as being the teacher space where they get all of their information from, and it is possible for children to work without it….although in a standard lesson they would have use of it, they adapted very well to not having it, and they didn't seem to think "oh, we've not got the whiteboard any more"'.

BUT

Wider school constraints may apply, and particular individual circumstances may combine and intervene (such as technical capability and self-efficacy)

For instance, pupil grouping and experience may be problematic:

'In one of mine, one of the children was away on holiday for one of the filmings and I put another child in the group and it really didn't work. They were just disagreeing with each other all the time. The science didn't really happen, they were just arguing.'

and curriculum demands may be perceived by the teacher and the children:

'Not all the objectives could be covered with talk, open-ended tech things, sometimes they just needed to know the task. Hopefully that will change. I think there's a need for children to know the facts and if they haven't got that then they're not going to be able to discuss.'

One of the main problems relates to perceived expectations about handwriting on the IWB:

'Handwriting is quite a big drive at the school…two of (the children) wrote their handwriting on there and if they didn't think this is was a standard that would be accepted they would rub it out and they spent ages trying to get it so neat. What they were writing was fine, you could read it, but they wanted it perfect.'

'....quite interesting for me was the fact that the children almost put their spoken word as secondary to the written outcome. …There were a couple of times where the children found themselves writing out reams and reams of text and they used the extended page button fantastically well, but I never asked them to write down what all of the things were…and justify their reasons, they just felt that they had to write it down. They almost didn't appreciate the full value of what they were talking about and they felt that they had to have something written down, even though it wasn't asked for….I think, because they've

got the ghost presence of the teacher, they're always trying to jump through the hoops that they would expect you to ordinarily want them to do.'

'…whilst they've got the ghost teacher they've brought standard routines and practices with them, and they're taking normal classroom practice to new technology…it's one of those things where if I did it again I'd say the value of your talk is more important than what you write down.'

'If they did it somewhere else possibly, like a youth centre, maybe they would adopt a different stance on it, but they're very good children at conforming to the rules and the expectations within a given environment, so although they're using something technological, they're using the technological item in the school environment.'

Teachers' own technical competence came to the fore as a key factor:

'Between locking and freeing there's a sort of half way house where you can have infinite clones, whereby the children have a locked image that's fixed in position, but because of the infinite clone facility they can have as many copies of that image as they like.'

'Without technical expertise you're not going to have an understanding of what the board has to offer and how to make it work. It you try to develop an activity without using copy and paste, without using all the basic things that we use on a day to day basis, they're all technical expertise, they're all the things that we use…..I think the things that we do in the primary sector because we've had them for longer shows that we use technical expertise on a day to day basis, and just basic instruction of a show or a presentation or a learning activity with an outcome, I would say that's technical expertise.'

We asked a group of the teachers involved in the project to rank the difficulties they had encountered in using the IWB for children's collaborative learning in their own classrooms, drawing initially on a general list of issues generated from our preliminary analysis. The top ranked difficulty within the group referred to:

Time – in terms of both additional teacher preparation time and the time that the given group of pupils spend at the board compared to other groups at their tables in that lesson

The teachers' rankings also highlighted other relatively common difficulties, such as the general problems arising when there is a poor match between task design, curricular demands and IWB use.

However we also found clear differences between the teachers in terms of their own skills, interests and classroom circumstances. For instance, 'technical issues' were ranked highly as problems for approximately half the group and relatively low for the rest. 'Restrictions of physical space' were ranked low for most of the group, except for one teacher who placed this difficulty near the top of his list. 'Insufficient emphasis on how to talk productively in groups' was ranked at the mid-level for the majority, except for one teacher who placed it near the top and another who placed it at the bottom of his list. A similar pattern emerged for 'too large or small group size', although two different teachers placed this higher or lower in their own lists.

Some teachers identified specific difficulties that went beyond our original list of general issues, such as:

'the translation between intended outcome and pupil interpretation of what the teachers wants'

'assessment for learning: who wrote/said what?'

'not being able to display information, prompts, etc for the rest of the class'

'ensuring equality of opportunity and that all groups cover objectives'

'when children view collaborative work as of a lower value than individual work'

'children at IWB rubbing out ideas – changing coloured pens – checking handwriting etc'

'when external pressure on teachers or pupils create difficulties, like fire drills'

'when the children's mood is not co-operative for reasons which you may or may not know'

In spite of these potential difficulties, some teachers also noted the opportunities created by this type of collaborative IWB use:

'I would have said this was a good activity though, for actually standing back with your tickboard and saying "yes, they've said this, they've said that", as long as you've got the others… that aren't working at the whiteboard doing something productive as well. You can actually stand there and assess them. It would be an opportunity.'

Others pointed out that teaching is full of the certain difficulties, with different levels of responsibility in daily activity and as part of the research project itself:

'Well, there are lots of external influences that can affect anything that you're doing. It's not just particular to an interactive whiteboard.'

'Well I think there's a difference between the things that you can change and the things that you can't. The things I can't change are (ranked) at the bottom – the physical constraints of my room,… my classroom ethos… - are not going to change…. So whether the task succeeded or not, it's not going to be due to that…..I think there's been a divide between the things that I'm ultimately accountable for (that) I've put at the top…All the things I'm in control of that we all have to do on a day to day basis were things I was most concerned about. At the bottom were the things which were the focus of the task itself, so "classroom preparation", "structure"…I was in control of those as a result of the actual project itself, so for me I didn't see those as an issue. These things up there that I did perceive as an issue are the things that I have to do and I have to make sure occur.'

All the comments from the teachers highlighted the importance of taking account of individual circumstances and wider constraints in understanding collaborative IWB use by the children, as well as the need to judge and develop this work over a period of time in the classroom.

'Yes, it's almost like the things (ranked) at the top are to do with priorities really aren't they, you have to choose your priorities don't you in teaching. They can change from term to term or from day to day, but to make this work I think you do have to probably make it a priority, at least for a certain amount of time.'

For some, the research itself made a difference to their thinking about IWB use and clarified their priorities within different curriculum areas. This led them sometimes to choose not to use the IWB given the different approaches and demands across the curriculum:

> 'I think it's definitely made me focus more on making sure the interactive whiteboard isn't just a projector, trying to use it more. It's usually actually within science that I use if for group work, it's in other subjects…quite a lot of time in English actually….Things like the meanings of poems and trying to get different words from them, pairing up synonyms, all sorts of things like that really. Whereas in science we tend to get out the physical equipment more.'