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Interactivity with the interactive whiteboard in *traditional* and *innovative* primary schools: An exploratory study

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One of the main affordances of the interactive whiteboard (IWB) is its potential for increasing classroom interactivity, yet little is known about the interactivity it supports in schools with different educational concepts. In this study we analysed what types of whole-class interactivity the IWB supports in schools with either a *traditional* or an *innovative* school concept. Interactivity was operationalized in terms of operation of the IWB, control of the IWB content, and the whole-class dialogue. A cross-case analysis of videotaped lesson observations revealed patterns in the interactivity related to school type. Comparison of the prevalent interactivity patterns at the two school types shows that students at the innovative schools had a more active role in the content of the IWB-supported lessons than those at the traditional schools. The students at the traditional schools operated the IWB more often, which coincided, however, with little or no student control of the IWB content and with whole-class dialogue that focused on knowledge transmission. At the innovative schools the active student role regarding lesson content did not coincide with student operation of the IWB. These findings indicate a link between the school's educational concept and the type of interactivity in IWB-supported lessons.

Introduction

Over the past decade the interactive whiteboard (IWB) has proved to be a valuable tool for teaching and learning. Earlier research on the use of the IWB as a pedagogical tool mainly explored the potential it might hold for education, as Glover, Miller, Averis, and Door (2005) show in their literature review. More recent studies focus on the advantages and disadvantages of the IWB as an educational tool (Cutrim Schmid, 2008; Slay, Siebörger, & Hodgkinson-Williams, 2008; Somyürek, Atasoy, & Özdemir, 2009) or investigate how the IWB is actually being used in pedagogical settings (Smith, Hardman, & Higgins, 2006; Haldane, 2007; Kershner, Mercer, Warwick, & Staarman, 2010).

Findings suggest that the IWB can be used to support different types of classroom interactivity. Although Smith et al. (2006) find in their study that the IWB is mostly used for whole-class teaching with a relatively high pace and frequent yet short student answers, other studies show that it can support both a teacher-directed and a more student-directed pedagogic approach to whole-class teaching (Gillen, Kleine Staarman, Littleton, Mercer, & Twiner, 2007). In this study we investigate what types of interactivity occur in IWB-supported lessons in schools with either a teacher-directed pedagogy or a student-directed pedagogy.

Classroom interactivity supported by the IWB

After the introduction of the IWB into the classroom arena, most studies focused on the use of the IWB to support whole-class lessons (Kershner et al., 2010). More recent studies focus on the use of the IWB in individual and group work by students as well, for instance in collaborative tasks in which children share ideas about a topic (Kershner et al., 2010; Warwick, Mercer, Kershner, & Kleine Staarman, 2010).

Its potential for supporting classroom interactivity is one of the main reasons given by teachers for adopting the IWB (Smith, Higgins, Wall, & Miller, 2005; Kennewell, Tanner, Jones, & Beauchamp, 2008). In the analysis of classroom interactivity supported by the IWB it has become customary to take both the technical and the pedagogical dimensions of the interactivity into account (cf. Smith et al., 2005; Kennewell et al., 2008). The technical dimension of interactivity – often referred to as technical interaction – relates to the operation of the board by the teacher and/or students, like browsing the internet

or showing and processing images or text (writing, drawing, dragging, clicking, et cetera). The pedagogical dimension of the interactivity – or pedagogical interaction – on the other hand encompasses all elements of the interactivity among teacher and students (or among students) that serve a pedagogical purpose (Smith et al., 2005; Evans & Gibbons, 2007). This dimension includes the teacher's pedagogical decisions that relate to technical interactions with the IWB, like whether or not to give students the opportunity to operate the board or to have control of the content on it. It also includes classroom dialogue about subject matter.

Interactivity in different models of learning and instruction

In the literature we find high expectations of how increased interactivity can engage students in their learning process in a more active way (cf. Beauchamp & Kennewell, 2010). One of the rationales behind these expectations is the assumption that actively engaged students have a higher learning motivation, which increases learning results (Beeland, 2002; Torff & Tirotta, 2010; Hennessy, Deaney, Ruthven, & Winterbottom, 2007; Slay et al., 2008). Another rationale is the assumption that learning by definition implies a process of knowledge construction in which the student plays an active role (Jonassen, 1992; Mayer, 2001).

Classroom dialogue is one of the key aspects of classroom interactivity (Wells & Arauz, 2006). In classroom dialogue it is traditionally the teacher who initiates the exchange and takes on the role of didactic expert (Smith et al., 2006) or "primary knower" (Nassaji & Wells, 2000, after Berry, 1981). The teacher transmits information through lectures. Subsequently the teachers' questions in this type of dialogue are primarily aimed at recitation of previously memorised information. Students' responses are evaluated in terms of correctness or conventionality (Mroz, Smith, & Hardman, 2000). This division of roles reflects the traditional division of power between teacher and students (Lemke, 1990), also associated with the instructional model of knowledge transmission. Nassaji and Wells (2000) point out that control is divided more equally if the teacher does not claim the role of didactic expert or primary knower. In that case the teacher asks more open questions and focuses on promoting understanding rather than transmission and recitation of information. This approach rather reflects the instructional model of knowledge construction (Rogoff, 1994).

Thus the nature of classroom dialogue and hence classroom interactivity appears to vary with the model of learning and instruction that underpins the learning activity in which the interactivity occurs. As the IWB can be used in very diverse pedagogical ways (Winzenried, Dalgarno, & Tinkler, 2010) it can reasonably be expected to support different types of interactivity in schools with different educational concepts.

Concept-guided development of ICT use

Research shows that a significant condition for the successful integration of information and communication technology (ICT) into the classroom is that the intended ICT use fits the school's educational concept. Zhao, Pugh, Sheldon, and Byers (2002) in this respect mention the importance of a minimal distance between an ICT innovation and the school's culture, i.e., the school's "dominant set of values, pedagogical beliefs and practices", while Tolmie (2001) points at the fit between the ICT resources that are used and the school's "established patterns of activity". Niederhauser and Stoddart (2001) stress that teachers are inclined to apply technology in a manner that is consistent with their "personal perspectives about curriculum and instructional practice". Developing ICT use in a "concept-guided" way promotes this fit between pedagogy and technology (de Koster, Kuiper, & Volman, 2012). Concept-guided development implies that the school's existing concept is clarified and that possibilities are explored to develop ICT use that supports this concept. By concept we mean a school's classroom practices (cf. patterns of activity) and the educational views (values, beliefs, and perspectives) underpinning these practices.

A previous study (de Koster et al., 2012) showed that this approach leads to clearly distinguishable types of ICT use, in line with the type of education that the school is aiming to provide. It is, therefore, to be expected that when schools develop their ICT use in a concept-guided way, the use of the IWB for supporting classroom interaction will vary according to the school's educational concept.

Method

The four schools in this study participated in a project in which ICT use was developed in a concept-guided way. The participating schools, classified as either traditional (mainly teacher directed) or innovative (mainly student directed), each developed a number of ICT-rich learning arrangements in a concept-guided way. Each school type developed a distinguishable type of ICT use (de Koster et al., 2012). However, one tool that was included in learning arrangements across the school types was the IWB. As the IWB can be expected to support different types of interactivity in schools with different educational concepts, this aspect of IWB use became the focus of our investigation. So far the types of interactivity supported by the IWB in schools that develop their use of the IWB in a concept-guided way had not been investigated.

The main research question for this study was: What types of classroom interactivity does the IWB support in traditional and innovative schools that develop their ICT use in a concept-guided way?

Classroom interactivity in this context refers to all pedagogical interactions in whole-class situations, both with the IWB and in teacher-student dialogue. We focus on whole-class lessons, as the schools in this project all primarily used the IWB to support whole-class teaching.

Participants and setting

The four schools in this study participated in a project in which they developed ICT use in a concept-guided way. The participating schools had educational concepts that were labelled as either traditional or innovative. The traditional label refers to a fixed curriculum and a strongly teacher-directed approach, while the innovative label indicates a more open curriculum with a focus on self-regulated learning.

Of each school type two schools are represented in this study. The two traditional schools follow a mainly textbook-driven curriculum, with relatively little input from the students. Whole-class, direct instruction is the main form of instruction. After instruction, pupils individually or in pairs process the lesson content in highly structured exercises and assignments. The two innovative schools have a more open curriculum. Students at these schools have more input in learning content and activities, often working on research projects that start from their own research questions. Whole-class instruction is less predominant; students typically spend most time working in small groups or individually, while the teachers often take on a coaching role.

Video observations of six lessons in six different classes across both school types were analysed. Each analysed lesson took place in the context of a different learning arrangement. The lessons were given by five different teachers; of one teacher two different lessons in two subsequent school years were analysed. The grade levels varied from second to sixth grade. Class sizes varied from 13 to 28 students.

Procedure and design

In the course of two school years the schools in this study each designed, developed and implemented up to four ICT-enhanced learning arrangements. The schools developed these learning arrangements in a concept-guided way, meaning that a team of teachers at each school was supported in designing and implementing learning arrangements in line with their school's educational concept (cf. de Koster et al., 2012). The teachers were supported by educational counsellors specialised in guiding innovation projects. With these counsellors the teachers reflected on their school's educational concept and its ambitions for intensifying its use of ICT in line with this concept. This way we expected the schools' educational concepts to be reflected in the resulting ICT-enhanced learning arrangements.

Data collection

Several lessons in each learning arrangement were observed and in most cases recorded on video. For this study we selected three videotaped lessons per school type that were likely to give a meaningful and comprehensive picture of the IWB practices at the different school types. Most IWB-supported lessons mainly comprised whole-class interactions between teachers and students. We selected lessons that included a considerable amount of dialogue between teacher and students in order to study these whole-

class interactions. The lessons were divided into episodes – i.e., clearly distinguishable parts, divided by for instance a change of topic – of which only the whole-class episodes were analysed. This led to an analysis of eight whole-class episodes for each school type, 2 to 20 minutes long and with an average of 8 minutes per episode. A total of 128 minutes of observation footage was analysed. Relevant episodes of group or individual work by students are briefly described as part of the context.

Microanalysis: types of IWB-supported interactivity

We performed a microanalysis of the interactivity in the six lessons that were selected, in order to find patterns that would help characterise the interactions in IWB-supported lessons. For this microanalysis all whole-class interactions in the selected episodes were transcribed, including all content-related whole-class dialogue and all technical interactions with the IWB. During the analysis we noted down the following characteristics of each lesson: the subject of the lesson, the grade and the lesson outline, including the general goal of the lesson (covering new subject matter or repeating previously covered content, et cetera), and the main content on the IWB. These aspects functioned as the context necessary for the interpretation of the interactions (Green & Dixon, 2002).

With regard to the interactions with the IWB we distinguished two aspects:
1. Operation of the IWB: who operated the board? Either the teacher exclusively operated the IWB (labelled as *teacher*), or the teacher let one or more students operate the board (*student*) or both teacher and student(s) operated the board (*shared*).
2. Control of the content on the IWB: who decided what was written or shown on it? Possible values are *teacher* if the students had no input in the content on the IWB (e.g., the teacher did not ask for contributions or did not write down students' contributions), *student* if all content was provided by the students (e.g., only the students' contributions were written on the board), or *shared* in all other cases.

The dialogue was described in terms of the teaching and learning model apparent in the dialogue. This could be labelled as either *knowledge transmission* (i.e., the teacher primarily transmits information and/or prompts students to recite previously transmitted information) or *knowledge construction* (i.e., the teacher tries to induce students to think actively and construct knowledge, focusing on understanding rather than recitation).

In a cross-case analysis these descriptions were compared in order to find possible patterns of interactivity per school type (Miles & Huberman, 1994). Reliability of both the fragmentation and the analysis was ensured by the creation of an audit trail and discussion of the data with co-researchers to check for agreement (Graneheim & Lundman, 2004).

Results

In this section we discuss our findings on the types of IWB-supported classroom interactivity. The lessons at the traditional schools are discussed first, followed by a discussion of the lessons at the innovative schools. Each of the three aspects of interactivity (IWB operation, control of IWB content, and dialogue) is described and illustrated with exemplary excerpts from the observation transcripts. We conclude this section with a comparison of the results of both school types.

Interactivity in IWB-supported lessons at the traditional schools

Descriptions of the lessons analysed
Lesson 1 consisted of two episodes. In episode 1a the teacher went over spelling rules that had been covered in an earlier instruction lesson and asked some students to do an exercise on these rules on the IWB. In episode 1b the teacher went through some exercises as a preparation for the students' individual work in their exercise books.

Lesson 2 was divided into three episodes. In the first episode (2a) the teacher asked the class to compare two similar texts on the IWB. She then asked a student to show on the IWB how he would look for certain information on a specific webpage (2b). In the third episode (2c) the teacher asked this student and

some other students to type the information they found in their own words in a Word document displayed on the IWB. The teacher herself typed the final sentence, formulated with the students.

Lesson 3 also comprised three episodes. In the first and third episodes (3a and 3c) the teacher discussed a task card that was projected on the IWB. In the second episode (3b) she discussed the outcomes of an exercise from the card with the class.

Table 1 summarises the contextual characteristics of the lessons at the traditional schools.

Table 1
Lessons at the traditional schools: Context information

Lesson	School	Grade(s)	Subject	Lesson outline	Main content on IWB
1	A1	3	Language	Going over previously learned linguistic rules again and doing exercises	Exercises from students' exercise books and exercises prepared by the teacher
2	A1	3	Science	Discussion of internet searching in the context of assignments on finding and processing information	Two prepared texts, a webpage and text written by students
3	A2	2	Science	Introduction of a system of task cards as part of a new science method	Teacher shows a task card

Interactivity patterns
Table 2 shows that at the traditional schools the IWB was operated by the teacher in five of the eight episodes, while in three episodes the operation was shared by teacher and students. With regard to the control of the content on the IWB, we found that in seven episodes the teacher fully controlled the content, while in one episode the control was shared. The dialogue in the lessons at the traditional schools reflected knowledge transmission as the main goal in five episodes, while in three episodes the dialogue was aimed at knowledge construction. The interactivity is summarized in Table 2 and is described in more detail below.

Table 2
Overview of interactivity patterns per aspect at the traditional schools

Lesson	Episode	Operation of IWB	Control of IWB content	Type of dialogue
1	a	Shared	Teacher	Transmission
	b	Teacher	Teacher	Transmission
2	a	Teacher	Teacher	Transmission
	b	Shared	Teacher	Construction
	c	Shared	Shared	Construction
3	a	Teacher	Teacher	Transmission
	b	Teacher	Teacher	Construction
	c	Teacher	Teacher	Transmission

Operation of the IWB
During the introduction to the exercise on the IWB in episode 1a, the teacher operated the board herself. The exercise consisted of two versions of twelve words across two columns. Each word was spelt correctly in one column and incorrectly in the other. The students had to identify the correct word and click on it. For each word pair the teacher asked a student to come to the IWB. If necessary the teacher assisted the students in operating the board. In episode 1b the teacher went through the exercises that the

students were going to do individually in their exercise books. She had scanned these exercises, primarily fill-in exercises, from the exercise book and projected them on the IWB. For each exercise the teacher filled in at least one outcome on the IWB.

In lesson 2 the students first responded to two texts that the teacher projected on the IWB (2a). The teacher then asked one student to navigate a webpage on the IWB to show how he would look for certain information on that page (2b). In episode 2c this student and some other students typed the information they had found in their own words in a Word document displayed on the IWB. The teacher concluded this lesson by typing a final sentence, with input from the students.

In lesson 3 the teacher operated the board herself throughout the whole lesson. The intensity with which the IWB was used was relatively low, as the teacher only used it to project the digital version of the card that she was discussing with the class and to point at the text and symbols shown on the card when referring to them. During the second episode (3b) the IWB was not referred to, although the teacher did ensure that the task card remained on the screen when it went into stand-by mode after a while.

Content on the IWB
The teacher mainly determined the content on the IWB in all three lessons at the traditional schools. In lesson 1 the teacher selected and prepared the exercises that she and the students did on the IWB. The exercises have a closed character, with only one correct answer. In episodes 2a and 2b of lesson 2 the content on the IWB consisted of two similar texts about castles, written by the teacher, and a preselected page from a website. The teacher prepared all of the content in these two episodes. In episode 2c the assignment in which students wrote the information they had found in their own words was more open-ended, thus giving the students more control of the content. Within the context of the preselected webpage they could decide which information they found most important and use their own words to reformulate this information. In lesson 3 the content on the IWB only comprised the task card that was discussed, giving the students no control of the content at all. In episode 3b the teacher did not write students' answers on the IWB.

Dialogue
The dialogues in most of the episodes at the traditional schools consisted of knowledge transmission by the teacher and prompting of student recitation. In lesson 1 the teacher checked how well the students had memorised and understood the linguistic rules learnt in a previous lesson. She only asked for conventional answers, testing the students' ability to give the conventional explanations of grammatical terms (example 1.1) and to apply the rules they had learned in the exercises (example 1.2).

Example 1.1
The IWB shows two columns of words with the names of two spelling rules at the top. There is a grey bar above the names of the rules.

Teacher	[…] I would like to hear it once more. Who can tell me what the acorn rule is. Do I see all hands go up? Almost. Vincent.	
Student	After a long sound, one consonant.	
Teacher	You know it.	Clicks on the grey bar on the board. The rule appears
	Now I wonder… Wow. Long sound, one consonant.	

Example 1.2
The same two columns are on the IWB. After explaining the exercise to the students the teacher asks one of them to do the first word.

Teacher	Do we get it? Okay, David, can you read the next two words out loud?	
Student	Ontdeking [*discovery*, misspelled] Ontdekking [*discovery*, spelled correctly]	Teacher points at the words, following the student's reading pace

Teacher	Well, show us what you think.	
Student	[goes up to the board, teacher hands him the digital pen]	Clicks on one of the words; "correct" appears
Teacher	Yes, it's correct.	
	Fantastic, David.	

In the first episode of lesson 2, in which the students had to identify the differences between the two texts on the IWB, the teacher asked the students seemingly open questions. Yet as the lesson unfolded it became clear that she was looking for one specific answer, namely that the main difference was that difficult words, i.e., academic language, were used in one of the texts, while the other text was written in words that students would use themselves, i.e., language appropriate for this age group (example 1.3).

Example 1.3
The teacher first projects a short text about castles on the IWB, written by herself in academic language. She asks the students to read it for themselves and to say what they think of it and why. The students mention the use of difficult words and the teacher keeps asking for other criteria. She then projects a second text about the same subject, also written by herself but in more accessible language. Again she asks the students for their opinion.

Teacher	Aidan.	
Student	[inaudible]	
Teacher	You also see a difficult word. Yes, that's a difficult word too.	
	Is there another reason why you think this text isn't so good, besides having difficult words?	
		Clicks on the board to open next text
	Janet.	
Student	Well, I think this one is good, because here they explain more. For example, what's an entrance, well, that's a thing for … it's a castle's door.	
Teacher	Almost right.	Points at board, where it says "opening" instead of "door"
Student	Yes, opening. And it's written in ordinary words.	
Teacher	[points at student] I think it's great that you say that, in ordinary words, yes.	

In episodes 2b and 2c the teacher's questions became more genuinely open-ended and more focused on students' own explanations and thus on knowledge construction by the students. In episode 2b the teacher asked the student at the IWB to show how he would look for specific information on the webpage (example 1.4).

Example 1.4
The teacher has opened a webpage about castles on the IWB. She asks a student how he would search the page for information on how a castle is built and asks him come to the board to demonstrate his search strategy.

Teacher	Who can tell us, say we're going to do this in a minute, on the computer, what do I start with? What am I going to do first?	
Student	Look for information […]	
Teacher	Yes, I have that here. Tell me what I should do then. [Reading from the board:] How is a castle built?	Opens web page
Student	Then you read everything that it says, and then…	
Teacher	Am I going to read everything?	
Student	No…	
Teacher	So from top to bottom I'm going to read all this.	Scrolls down to end of page and back up
Student	No, then you look for the chapter how is a castle built?	

Teacher	Right. Can you look that up for us?	
	[…] Get a chair.	Hands student the digital pen
Student		Starts scrolling down through the text; looks at the text as it goes up the screen
Teacher	What are you looking for now? What are you looking at?	
Student	How a castle is built, at the chapter titles.	
Teacher	[taking a step towards the board] Right. So you look at the red letters, at the titles, whether you can find a title about building a castle. Very good.	

In episode 2c the teacher asked the student at the IWB to write the information he had found in his own words. Two other students were also asked to write a sentence. Because the students' texts immediately appeared on the IWB as they typed, the whole class could closely follow the writing process. Both the class and the teacher commented on what the students were writing as they typed (example 1.5). Students dictated the final sentence while the teacher typed it.

Example 1.5
The teacher asks some students to reformulate the information found in their own words and write a sentence on the IWB, using a keyboard in the middle of the classroom connected to the IWB.

Teacher	What are you going to type?	
Student	That below the ground there are traces of wood.	
Teacher	Yes. You can write that down.	
Student		Types, looking at keyboard.
	[Close-up of board shows that the student makes a mistake in the text and goes back to correct it]	
Teacher	There's a red line underneath it, what does that mean?	
Student		Corrects the mistake.
Teacher	Right, that's very good.	
Student		Finishes the sentence.

In episodes 3a and 3c the teacher read and explained the text on the task card projected on the IWB out loud. In the first episode she also asked some of the students to read part of the text and explain what it says (example 1.6). She corrected the students' reading mistakes without comment. The teacher also demonstrated what the text and icons on the card mean, for instance, by showing them how they could find the right card from the box of task cards..

Example 1.6
The teacher asks a student to explain two icons on the task card on the IWB.

Teacher	Then we see another icon.	Points at icon of two figures on the card
	What does that mean? Two people, Simon?	
Student	Well, that you have to work together.	
Teacher	Oh, so working in pairs.	
	So we are going to work in pairs, as I will explain later.	
	There's a 1. Do we have to do 1 assignment?	Points at board
Student	No. Grades 1 and 2 have to do it.	
Teacher	Very good.	

The next episode (3b) consisted of a whole-class discussion on the outcomes of an assignment in which pairs of students discussed different forms of transport with each other. In this whole-class discussion the teacher gave little feedback on the students' answers, accepting most answers with a short evaluation

(example 1.7). She did not write the students' answers on the IWB. Throughout the lesson the IWB only functioned as a means of reference.

Example 1.7
The teacher summarises some of the forms of transport that she has heard the pairs of students discussing and then asks students to add to her summary. The task card is still projected on the IWB, but there is no interaction with the board in this fragment.

Teacher	Now tell me… raise your hand if you know with what other forms of transport you can go on vacation. Mary.
Student	By plane, by car, by bike…
Teacher	Yes.
	Matthew?
Student	On foot. By camper. By… I don't know what it's called. A thing, like…
Students	[mention vehicles, hard to hear]
Teacher	Aha, a tram.
	Mustafa.
Student	Boat.
Teacher	Yes, with a boat you can.

Interactivity in the IWB-supported lessons at the innovative schools

Descriptions of the lessons analysed
For this study three IWB-supported lessons at the two innovative schools were analysed. Again eight episodes were distinguished. Lesson 4 consisted of two episodes revolving around a presentation by a pair of students, based on a WebQuest they had done about bullying. In episode 4a, which took place just before the presentation, the teacher discussed with these two students and the class how the students had tackled the assignment. In episode 4b, immediately after the presentation, the teacher commented on one of the points that the students made in their presentation.

In lesson 5 the teacher made a mind map on the IWB as an introduction to the new topic of "our house". This lesson consisted of two episodes, the second episode starting with the introduction of a new sub-theme by the teacher.

Lesson 6 also mainly consisted of making a mind map. This lesson counted four whole-class episodes. First the teacher discussed with the students the assignment on acquainting themselves with the topic "the Caribbean" by looking for information (6a). The teacher then made a mind map of the information that the students had found during the assignment (6b) and asked the students to formulate research questions based on this mind map. She discussed with the students what criteria a research question has to meet (6c). The students then formulated research questions in pairs that were subsequently discussed during a whole-class discussion (6d).

Table 3 summarises the contextual characteristics of the lessons at the innovative schools.

Table 3
Lessons at the innovative schools: Context information

Lesson	School	Grade (s)	Subject	Lesson outline	Main content on IWB
4	B1	2/3/4	Science	A presentation of students' research results; discussion of the process of research and making the presentation	WebQuest, slideshow in *PowerPoint*
5	B2	4/5/6	Science	Exploration of new topic	Teacher makes a mind map
6	B2	4/5/6	Science	Exploration of new topic and formulation of research questions by students	Teacher makes a mind map and writes students' research questions on IWB.

Interactivity patterns
The teacher operated the IWB in seven of the episodes at the innovative schools, while in one episode the operation of the IWB was shared. In none of the episodes was the IWB operated only by students. Both teacher and students determined the content on the IWB together in seven episodes, while in one episode the content was fully determined by the teacher. No whole-class episodes with fully student-controlled IWB content were observed. The whole-class dialogue at the innovative schools was exclusively aimed at knowledge construction in all eight episodes. Table 4 summarises these findings and they are described in more detail below.

Table 4
Overview of interactivity patterns per aspect at the innovative schools

Lesson	Episode	Operation of IWB	Control of content on IWB	Type of dialogue
4	a	Shared	Shared	Construction
	b	Teacher	Shared	Construction
5	a	Teacher	Shared	Construction
	b	Teacher	Shared	Construction
6	a	Teacher	Teacher	Construction
	b	Teacher	Shared	Construction
	c	Teacher	Shared	Construction
	d	Teacher	Shared	Construction

Operation of the IWB
During episode 4a the teacher and the students who had made the presentation operated the IWB together. The teacher operated the IWB in reaction to what the students said. For instance, when the students mentioned the WebQuest that led to their presentation the teacher used his laptop computer to open this WebQuest on the IWB. During episode 4b the teacher operated the IWB, this time to go back to a slide that he wanted to discuss with the students. In lessons 5 and 6 the IWB was only operated by the teachers, who wrote the students' contributions on the board. In lesson 5 the teacher decided twice that the page had become too full and opened a new mind map. In lesson 6 the teacher used the IWB to project a clock (6a and 6c), to make a mind map (6b) and to write students' research questions (6d).

Content on the IWB
In lesson 4 the content on the board was alternately provided by the students and the teacher.
The students provided most of the content on the IWB in lessons 5 and 6. In lesson 5 the students provided keywords for the mind map that they associated with the topic "our house". In episode 5a the teacher divided the mind map into categories, some of which were suggested by students. The teacher discussed with the students which category a keyword belonged to. When the page become too full the teacher opened a new mind map and entered the students' contributions (5b).

In episode 6a the teacher used the IWB for projecting a clock, indicating the time the students had for this assignment. In the next whole-class episode (6b) the teacher used the IWB to write keywords from the information students had found. Some of the keywords were formulated by the students, sometimes slightly modified by the teacher. In episode 6c the teacher again projected a clock on the IWB for the next assignment. After group work on formulating research questions the teacher wrote the students' research questions on the board during a whole-class discussion (episode 6d).

Dialogue
In episode 4a the teacher played an active role, mainly focusing on the process of performing a WebQuest and making a presentation. He asked the students who had made the presentation to clarify what they had done. The teacher then explained the activities to the youngest students or asked other students to explain. He summarised or further clarified students' answers and explanations (example 2.1). In episode 4b the teacher discussed a suggestion for further research with the students who presented their research results.

Example 2.1
The teacher asks the students who made the presentation to explain how they have found the information that they are about to present to the class.

Teacher	Okay, so you started with a mind map.
Students	Yes, we started with a mind map…
Teacher	[to the class] Who can tell me why they started with a mind map? Grade 4 students know this, I wonder if grade 2 and 3 students also know.
Student 1	Then they could first learn something and… I can't explain.
Teacher	Who can explain?
Student 2	Because then you learn more about the topic…
Teacher	That's not completely correct, because you don't look for information to put in the mind map. Mickey?
Student 3	Well, you make the mind map because it has things that you haven't looked up but that you already know about bullying and you look up that which you don't know so much about.
Teacher	Okay, well said. So you use a mind map to arrange your thoughts. What do I already know? And you also find out what you don't know yet. And that's what you can then research.

Most of the whole-class dialogue in lesson 5 and a considerable amount of lesson 6 (episode 6b) revolved around the mind maps on the IWB. In lesson 5 the mind map served the goal of activating students' prior knowledge. In episode 6b the students' contributions were based on their internet search assignment at the beginning of lesson 6. Both teachers sometimes asked the students to clarify their contributions for the mind maps (example 2.2) or how the keyword was spelled before writing it down.

Example 2.2
In lesson 5 the teacher asks the students to provide keywords for the mind map on the topic "our house".

Teacher	Lucas.
Student 1	Bay window.
Teacher	What is a bay window?
Student 1	[tries to explain what he means, inaudible]
Teacher	[Repeating the student's response, jokingly] A circle at your house. So you put all your chairs in a circle?
Student 1	[tries to explain with gestures what he means]
Student 2	Like an annex thing.
Teacher	So a bay window is an annex. It's not exactly the same. An annex isn't necessarily a bay window, but a bay window is a kind of annex.

In episode 5a the teacher divided the mind map into categories. She often referred to these categories and actively involved the students in using the categories, for example by asking them which category their contribution belonged to (example 2.3).

Example 2.3
In lesson 5 the teacher asks the students to provide keywords for the mind map on the topic our house. One of the mind-map categories was 'construction'.

Student	Iron.	
Teacher	Where do you want me to put that?	
Student	Well, there at the construction of the house. Because sometimes they have iron beams […].	
Teacher	I'll write iron beams.	Teacher writes iron beams

In episode 6a the teacher explained the assignment on searching for information about the topic "the Caribbean" and asked the students where they thought they could find this information. In episode 6c, before the students started to formulate research questions, the teacher asked them to sum up criteria for a

good research question (example 2.4) and she negotiated with them on the amount of time they were going to need to formulate good research questions of their own.

Example 2.4
In lesson 6 the teacher asks the students what criteria a good research question must meet, before starting to think of their own research questions. She elaborates on the students' answers.

Student	That you know exactly what you want to know.
Teacher	That you know exactly what you want to know.
	So it should not be a very general question.
	Judy?
Student	A question that you don't know yourself.
Teacher	Very good.
	To which you don't know the answer yet.
	Because otherwise it's no use. Then you already know it, so you don't want to investigate it.

Comparison of interactivity patterns between school types

Tables 2 and 4 show the following interactivity patterns. The most common interactivity pattern at the traditional schools consisted of teacher operation of the IWB together with teacher-controlled IWB content, and dialogue that focused on knowledge transmission. This pattern was evident in four out of eight episodes. Four other patterns were found that showed a more active role of the students, in terms of operation of the board (three episodes), IWB content (one episode) and/or dialogue characterised by knowledge construction (three episodes).

All eight episodes at the innovative schools showed a focus on knowledge construction. In six episodes this was combined with teacher operation of the IWB and shared control of IWB content. In one episode both the operation of the IWB and control of IWB content were shared, while in one episode both were teacher controlled.

Two patterns were found at both school types, each occurring once. In both the traditional and the innovative schools we found one episode in which the teacher operated the IWB and controlled the IWB content, while aiming at knowledge construction. The other pattern, also found in one episode in each school type, consisted of shared IWB operation and control of IWB content combined with dialogue characterised by knowledge construction. Table 5 shows these patterns and their frequencies.

Table 5
Frequency per interactivity pattern per school type

Interactivity per aspect			Frequency per school type	
Operation IWB	Control IWB content	Dialogue	Traditional	Innovative
Teacher	Teacher	Transmission	4	-
Teacher	Teacher	Construction	1	1
Teacher	Shared	Transmission	-	-
Teacher	Shared	Construction	-	6
Shared	Teacher	Transmission	1	-
Shared	Teacher	Construction	1	-
Shared	Shared	Transmission	-	-
Shared	Shared	Construction	1	1

These differences between the school types might partly be related to student age, since at the traditional schools only grades 2 and 3 are represented in the study while at the innovative schools grades 2 through

6 were included (see Tables 2 and 4). However, the most prominent interactivity pattern found at the innovative schools was observed across all grades represented in the study. This reinforces the impression that the found differences can be attributed to the schools' educational concepts rather than student age.

Conclusion

In this study we explored what types of classroom interactivity the IWB supported in four schools that developed their ICT use in a concept-guided way. Two schools had a traditional educational concept, characterised by a mainly textbook-driven curriculum, direct instruction and highly structured exercises. The other two schools had an innovative concept, characterised by a more open curriculum, with more input from students and a coaching role for teachers. We looked for patterns of interactivity within and across these two school types. We analysed the interactivity with the IWB in terms of who operated the board and who was in control of the content on the board. We further analysed whether the dialogue during the IWB-supported lessons focused on transmission or construction of knowledge.

Based on their educational concepts, one would expect the IWB operation and content at the traditional schools to be mainly teacher-controlled and dialogue to be directed at knowledge transmission, while at the innovative schools the IWB use could be expected to be mainly student-controlled and dialogue to be focused on knowledge construction. Our findings, however, are not that unequivocal. In the lessons at the traditional schools the most common interactivity pattern found was teacher operation of the IWB together with teacher-controlled IWB content and dialogue that focused on knowledge transmission, as could have been anticipated. Yet other patterns, with a more active student role, were found as well. And even though the innovative schools' educational concept would suggest an active role for students, surprisingly in most episodes the teacher operated the board, while sharing control of IWB content with the students. Dialogue was focused on knowledge construction as could have been expected.

These findings firstly indicate that the use of the IWB did indeed occur with distinguishable typical patterns of interactivity that varied between these two school types. Secondly, our findings also show that the IWB-supported interactivity was not always in line with what could have been expected based on the schools' educational concepts. Most conspicuously, in the innovative schools it was mainly the teacher who operated the IWB.

One characteristic that all four schools in this study had in common was the fact that the IWB was almost exclusively used in whole-class lessons. This confirms the findings from other studies that the IWB appears to reinforce whole-class teaching. However, our findings contradict the suggestion by for example Moss et al. (2007) that use of the IWB also leads to more transmission-style teaching and that it reduces the classroom interactivity to the direct interaction with the IWB. Both the innovative schools and the traditional schools in our study provide examples of the IWB being used to support whole-class teaching in which students had an active role in controlling the content on the IWB and/or in the dialogue. The diversity of interactivity patterns in traditional schools and the occurrence of some innovative episodes in these schools, may even indicate that the IWB facilitates a transition to a more active role for students in the teaching-learning process.

Distinguishing the aspects *operation of the IWB*, *control of IWB content* and *dialogue* in the analysis of interactivity has proven useful in this study; it has provided us with a detailed and nuanced picture of what goes on in traditional and innovative schools when the IWB is used. Our findings thus contribute to insight into the variety of ways the IWB is and can be used in educational practices. They also underline that interactivity of IWB use should not be judged on the basis of who operates the board alone. An active role for students in operating the board can go hand in hand with teacher-dominated transmission-style teaching. This has clear implications for educational practice. When developing learning arrangements with the IWB it is important to be aware of these different aspects of interactivity; this awareness can help teachers to make conscious decisions about the type of interactions they intend to invoke.

Notwithstanding the nuances, a relation between the school's educational concept and the IWB-supported interactivity in whole-class lessons was found. The situations described in this study can therefore serve as examples for educators who want to develop IWB use in a concept-guided way. Our finding that teachers do indeed develop IWB-supported lessons with types of interactivity that fit the educational

concept of their school can furthermore promote realistic expectations with regard to the impact that the IWB has on classroom practice in a particular school type.

The fact that the most prominent interactivity patterns within each school type occurred in all grades represented in the study suggests that the differences in interactivity patterns found between the school types are unlikely to be explained by student age alone. For future research into the relationship between educational concepts and patterns of interactivity, however, we suggest a more even distribution of grade levels across the school types in order to rule out the possibility that the found patterns are related to student age rather than educational concept. A larger sample and a more evenly distributed representation of both science and arts lessons would also improve generalizability of these findings and deepen our understanding of the patterns and relations that were found.

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