Final report: “Board or bored?”

Gunstein Egeberg and Tor Arne Wølner (eds)

Background

The project group

Project management at Gulskogen School, Rødskog School, and the municipality of Drammen:

Lena Kilen, section manager, Gulskogen School
Thomas Larsen Sola, manager of activities, Gulskogen School and Rødskog School
Erik Westrum, advisor for the *Norges beste skole* (Norway's best school) project, the municipality of Drammen

Other members of the school management at Gulskogen School and Rødskog School who participated in gatherings, meetings, and planning:

Jon Jørgensen, section manager, Gulskogen School
Marianne Støa, section manager, Gulskogen School
Randi Nysæther, section manager, Rødskog School

Teachers who have been filmed and observed in connection with the project:

Monica Myrvold Berg, seventh-grade contact teacher, Gulskogen School
Anne Grethe Aarnes, seventh-grade contact teacher, Gulskogen School
Line Grøtte, seventh-grade contact teacher, Gulskogen School

Vestfold University College (www.hive.no) and partners from the Oslofjord Alliance
Susanne V. Knudsen (project manager), professor, Vestfold University College
Tor Arne Wølner (project manager), associate professor, Vestfold University College
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Linda Wahlman Olsen, assistant professor, Vestfold University College
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Odd Eriksen, associate professor, Østfold University College

The Norwegian Centre for ICT in Education (www.iktsenteret.no)
Gunstein Egeberg (project manager)
Dina Dalaaker, advisor
Ove Edvard Hatlevik, researcher
Geir Olaf Pettersen, assistant professor, University of Tromsø

The municipality of Drammen:
The municipality of Drammen and the *Norges beste skole* project have allocated Gulskogen School NOK 200,000 in ear-marked funds for the project. Gulskogen School has co-financed the project with a similar amount (NOK 200,000) from its own budget. Smart Technologies has contributed with ten fully assembled Smart Boards, two sets of Response phones, and five Smart Document cameras, as well as an invitation to participate at a conference organized by Smart

Technologies in Canada summer 2010. A representative from Interactive Norway held four three-hour courses.

The project funds have been used for:

- Salary:
  - Project management
  - Participation in meetings and gatherings for management and teachers throughout the entire project
  - Substitute teachers to cover for teachers during their absence
  - Internal collaborative and planning meetings in the Norwegian part of the project and internally at the school
- Travel and board expenses in connection with gatherings in Sweden and Denmark
- Licenses for Smart Math Tools
- Fees in connection with Smart Board training (books and materials)
- Organizing a two-day gathering in Norway
- Catering in connection with gatherings and meetings

The Norwegian Centre for ICT in Education:
The Norwegian Centre for ICT in Education has spent approximately 1,500 hours on the project. This includes time spent on research, administration, meetings, travel, literature searches, dissemination, and the writing of reports. The centre has in addition spent NOK 250,000 on running the project.

The university colleges in Vestfold, Buskerud, and Østfold:
The Oslofjord Alliance (the university colleges in Vestfold, Østfold and Buskerud) have spent approximately 1,300 hours on the project. This includes time spent on research, administration, project management, meetings, travels, literature searches, dissemination and the writing of reports. In addition, OFA has spent NOK 100,000 on running the project.

Introduction

The interest and activities surrounding the use of digital tools and media in the classroom have recently changed in nature and form of debate, and there has been an increased willingness to view such tools from fresh perspectives. Some teachers remain concerned that pupils lack the necessary skills, while others have become more interested in the didactic element of teaching and learning. Our study focuses on teaching by means of IWBs (interactive whiteboards), classroom management, communication, and evaluation. Observations of these factors include the search for innovation within educational design. The question is whether the teacher as a good class leader manages to turn the IWBs in the classroom into a common area of learning. Is the teacher able to relinquish some of his or her "territory" and share the whiteboard with the pupils, so that it no longer belongs to the teacher but the entire class? In order to accomplish this when using the whiteboard to teach, the teacher should forego reduplicating his or her traditional teaching methods and instead develop his or her technique through the use of communication and new modes of reflection and evaluation. In a 2007 review of the literature on the use of IWBs, Higgins, Beauchamp, and Miller found that few studies conclude that interactive, innovative teaching took place in the classroom. The teachers spoke of pupils "owning" the lessons, and most of the lessons revealed prepared and organized teaching with access to good resources in the use of IWBs; however, it was nonetheless largely a case of adhering to standard blackboard teaching methods (Higgins, Beauchamp & Miller, 2007; Schuck & Kearney, 2008). Our area of focus has been the same, that is, to examine whether tools or technology can be transformed in regard to their usage, and whether their design and content might in turn influence how teachers use IWBs. Do the teacher's tasks as class leader change in any way, is the dialogue between teachers and pupils different than before, and are teachers able to develop their teaching by using IWBs? Does anything change in the educational design, or is it the case the choice of technology governs the educational design? In the study teachers and researchers have concurred that educational changes were called for and that a sociocultural perspective should be employed.

The pupils who participated in this study constituted a heterogeneous group. 47 % of the pupils speak both Norwegian and one other language at home, while 5 % speak only a language other than Norwegian at home. 35 % of the pupils have parents who were both born in other countries than Norway. In regard to attitudes to school, 95 % of the pupils agree that they want to learn as much as possible at school – the pupils exhibit in other words a positive attitude to school.

IWBs – access and areas of use

The observations in the study took place in two classrooms, both of which were equipped with two IWBs. The teachers used their own laptops that were installed with the required drivers and software for use with IWBs.

The subjects that were observed were Norwegian and math, and IWBs were used during all lessons. It emerged several times during our observations that the teacher allowed the IWB be a station where the pupils were to solve tasks in groups. It was only in the event of technical difficulties that IWBs were not used in the classes we observed, though we were not present for all the lessons. The pupils were always present, however, and throughout the report we refer to some of their comments on motivation and the use of IWBs.

Method

The project followed two groups of seventh-grade pupils and three teachers in the subjects Norwegian and math during a school year. The two groups of pupils were studied as a *single* case (Yin, 2005), and the study employs both qualitative and quantitative methods (Creswell, 2003). The Norwegian project group chose to follow seventh-grade pupils, as this was the same age bracket that was used in the parallel Danish and Swedish projects. The two pupil groups and the three teachers were selected by the school management. One of the major objectives of the project was to bring to light examples of and experiences with the use of interactive whiteboards. Several other international studies also followed classes for shorter (Glover & Miller, 2002; Beauchamp, 2004) or longer periods of time (Lerman & Zevenbergen, 2007; Zevenbergen et al., 2008).

Ethical guidelines

The Norwegian Social Sciences Data Services (NSD) has been duly notified of the data gathering, with associate professor Tor Arne Wølner, Vestfold University College, as project manager. Informed consent was acquired from guardians.

Data gathering

This is a case study that employed mixed methods, i.e. combined methods (Creswell, 2003; Moss, Jewitt, Levacic, Armstrong, Caradini & Castle, 2007; Schuck & Kearney, 2008) for gathering and analysis. The project sought to address several research questions, and it is difficult to answer such a variety of questions by means of a single method. The project therefore combined qualitative and quantitative methods for gathering data that could illuminate and answer the research questions as we defined them. The methods included observation, video observation, interviews, and questionnaires.

Observation. Several other studies have used observation (Schuck & Kearney, 2008; Mercer, Hennessy & Warwick, 2010) to become familiar with and obtain information about classroom activity. Our project observed selected classes in Norwegian and math. Since it is critical that such sessions are not hampered by the presence of too many observers, the various tasks were divided up among the researchers during the observations, with some filming and others taking field notes and completing observation forms.

We used two types of observation form. One type had predefined categories based on an operationalization of the study's research questions, where the purpose was to gain an impression of classroom activity and of what activities dominated during the teaching (Kleven & Strømsnes, 1998). The drawback with such a predefined form is that the observer can become affected by his or her preconceptions, and it may prove difficult to include noteworthy events that do not fit directly into the form. The second form was therefore more open-ended, and only noteworthy or unexpected events were recorded there. The time of the given activity was also recorded along with a brief description. The time specifications enabled us to link the forms to the video recordings, the field notes, and the more structured observation form.

Video observation. Video observation was employed during both the Norwegian and math classes. We chose to focus the camera on the activities that unfolded on the interactive whiteboard. This applied both when the teacher taught on the interactive whiteboard, and when one or more pupils worked at the board, such as when pupils solved problem sets in math class. In addition, a hand-held camera was used in some of the sessions in order to come closer to the group. The video recordings were transcribed for subsequent analysis.

Questionnaire: In mid-December 2010 the pupils were asked to complete an electronic questionnaire developed on Google Spreadsheets. This questionnaire included questions on how the pupils perceived IWB-based teaching in general and in the subjects of Norwegian and math in particular.

Interviews with teachers: The project group engaged in, and will continue to engage in, informal discussions with teachers in connection with planning sessions and observations. In mid-December 2010 a more formal group interview was conducted with the three teachers. One of the aims of the interview was to record their reflections on the use of interactive whiteboards. The teachers were also interviewed following the project's completion.

Interviews with pupils: Pupil interviews were conducted in May and June 2011, in order to obtain more in-depth descriptions of the pupils' experiences with and thoughts concerning the use of interactive whiteboards.

Data analysis

Throughout the project we gathered data in the form of observations, video recordings, interviews, and questionnaires. This enabled a variety of analytical approaches, but also entailed a number of challenges.

One approach to understanding the field may be to review and discuss the field notes, as well taking a closer look at various patterns in the predefined observation forms. Such an approach may help uncover not only individual examples but also more pervasive features of the teaching.

By using field notes and observation forms, analysis can be done simultaneously with the data gathering, and it can therefore be difficult to achieve an overall perspective on classroom activity.

The purpose of video observation is to be able to analyse classroom activity, whether of entire classes or portions thereof. It is also possible to use the observation form or field notes in order to return later on to activities that are particularly interesting, unexpected, or relevant for the research questions. The transcription software InqScribe (www.inqscribe.com) was used to help analyse data from the video observations. This software enabled us to enter codes, comments, and analyses of events, tasks, and statements. The analysis of the video material followed three levels. The first level pertained to situations, individual episodes, and statements that were identified on the basis of the research questions. These sequences were then transcribed and coded on the basis of whether they were a pupil statement or a teacher statement; for example, we identified every question the teachers asked in order to see what types of questions were posed in the classroom, and events with technical difficulties were also coded. In the third and final level, these situations were analysed.

Only to a lesser degree did the transcription record pauses and interruptions. Since some of the situations took place in front of the whiteboard, it was natural to include a description of what the pupil or the teacher was doing. Comments regarding actions have been placed in parentheses ( ), while other explanations have been placed in square brackets [ ].

We also surveyed the pupils in the classes and conducted descriptive analyses of the answers from this survey. The chosen method was a case study that examined the two classes as a single case. The underlying data are therefore not suitable for drawing general conclusions. We hope nonetheless that the replies from the survey may provide us with interesting information about how the pupils perceive and assess the use of interactive whiteboards.

Evaluation of the study's methods

As mentioned above, the study addresses several different research questions, something that requires a multiplicity of methods. A weakness of the study is therefore that it attempts to cover many topics concerning the use of interactive whiteboards, and it might be difficult to narrow the project's design and scope. However, given that this is a project with participation from several institutions and researchers, it is to a certain extent possible for the participants to narrow the focus through data selection and choice of analytical methods. One such example of narrowing the focus was our in-depth analysis of video recordings of fraction lessons in math class.

There are several challenges that arise when using a variety of methods. The *same* phenomenon may not necessarily be illuminated by using *different* methods – it might just as easily transpire that *different* phenomena or aspects are illuminated when different methods are used. It should also be duly noted that none of the methods in this project took precedence over the others. A

third point is that the project's selection was discretionary, so that it is problematical to transfer findings from this study to other schools. We want instead to use the project to bring to light examples of how interactive whiteboards are used. Many case studies on the use of interactive whiteboards have also been conducted in other countries (Glover & Miller, 2002; Beauchamp, 2004; Lerman & Zevenbergen, 2007; Schuck & Kearney, 2008; Zevenbergen et al., 2008; Mercer et al., 2010). Though there seems to be a need for a more experimental design concerning the utility of interactive whiteboards in teaching, this lies outside the scope of the current project.

THEORY

The Norwegian school system

The Norwegian school system (see Table 1) shares many qualities with its Swedish and Danish counterparts. The three Scandinavian countries are close not only geographically, but also in regard to culture and language. Many of the descriptions here will therefore more or less apply for the other two countries as well.

Table 1. The Norwegian school system (Skoleporten [The School Portal], 2011)

Primary school (K1–K10)	2957 schools	An average of 207 pupils per school	Many schools with fewer than 100 pupils, only a few with over 600
Secondary school (K11–K13)	442 schools	An average of 433 pupils per school	Many schools with fewer than 400 pupils, only a few with over 800
Private schools	5.3 % of the schools	Based on an alternative educational or religious platform	Of varying size, though mostly small

The Nordic project on the use of interactive whiteboards took as its premise that idiosyncrasies in the Nordic schools influence how the boards are used. Of several potential characteristics of the Nordic school, three are highlighted in this report: autonomy, finances, and the school's structure and authority.

The school's autonomy pertains to decision-making authority and the ability to exploit the scope of action provided by current rules and regulations. Autonomy can be analysed on different levels, from the policy level to the teacher's classroom practice.

The Nordic countries have expensive school systems, featuring many smaller schools and a generally low pupil–teacher ratio. The OECD's PISA evaluation collects various types of

information, including financial information. The 2010 report (with figures from 2007) shows that Norway spends 47 % more than the OECD average on its primary schools, while the corresponding figures for Denmark and Sweden are respectively 36 % and 24 % above the average. These three countries are among those that spend the most on primary schools, and figures from the upper levels of the school system reveal a similar level of commitment. However, there are differences both between these countries and not least between the various regions in each country; for example, the municipality of Bykle spends three times as much money on its schools as the municipality of Molde does. Even though the schools can be expensive to run, there is little doubt that the Nordic schools enjoy relatively generous economic frameworks. This means that the schools often have, in addition to a sizeable teaching staff, good access to varied and good teaching aids. Norwegian primary schools have for a long while been equipped with numerous computers – roughly three pupils per computer in recent years (GSI). The schools also have relatively good access to other types of digital tools, and over the past few years this has increasingly included interactive whiteboards. In 2010 the percentage of classrooms with at least one interactive whiteboard increased to 39 % (Futuresource, 2010), a significant rise from the previous year. Major investments are in other words being made to upgrade the technology in Norwegian schools. Even though there may be some differences, the situation will likely be more or less the same in Sweden and Denmark.

In Norway the distance between teacher and head teacher is small, a situation that has a longstanding historical tradition (NOU 18, 1995). The beginning of the twentieth century saw the establishment of a school council where tenured teachers were represented in addition to the head teacher (Dokka, 1988). Nearly all of the school's major and minor issues were to be dealt with by the school council, and the head teacher was expected to adhere to the council's decision. The school council was first abolished in more recent times, and the head teacher's position has gradually changed since then. In today's Norwegian school the head teacher enjoys a wide scope of action and wields significantly more authority than for only a few decades ago. There are of course rules and regulations for co-determination and school democracy, but the head teacher's position has been bolstered. There is nevertheless a major difference between the schools in regard to how much head teachers exploit their scope of action and how co-determination is practised at the individual school. Furthermore, it is only in recent years that head teachers have acquired formal leadership training, and many head teachers still lack such training. Head teachers therefore often have the same level of education and experience as the teachers they are meant to lead, something that commonly results in less distance between leader and employee in Norwegian schools. Some signs of this are that nearly everyone is addressed by their first name and without a title (including the pupils), that the dress code is often informal, that the tone at meetings and gatherings are by and large characterized by parity, and that the head teacher often participates in various parts of the school's activities. Several reports highlight challenges to the school's authority, and the topic is frequently on the political agenda. The (poor) scholastic results, noise and distractions, lack of structure, and social problems at a given

school are often linked to the school's and the teachers' authority. Other signs of a low degree of authority in Norwegian schools include the rare use of punishment and the freedom teachers enjoy to choose their own teaching method. Many will also emphasize the teacher's low status, something that is apparent in several studies.

Skills and maturity

In their description of how teachers use technology, Hooper and Rieber (1995) divide the process into five phases:

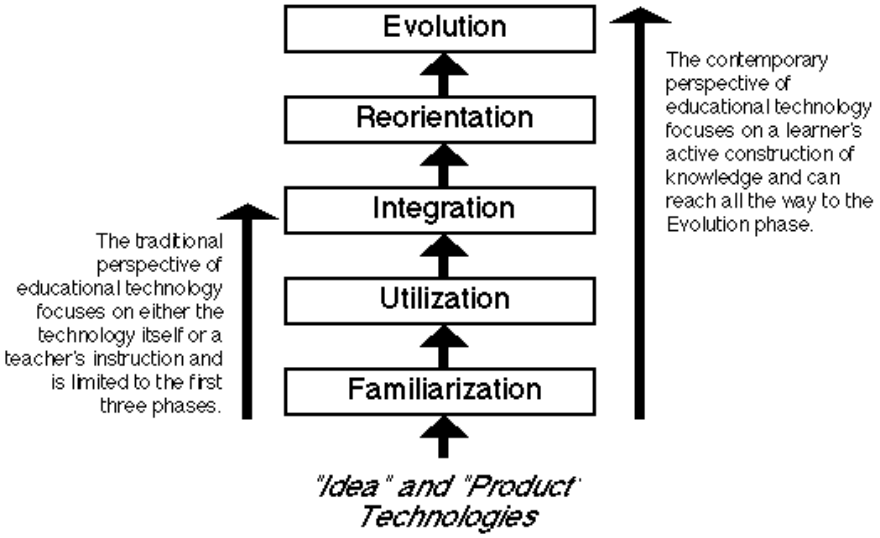


Fig. 1. (Hooper & Rieber, 1995)

In the first phase the teacher encounters the technology and familiarizes him- or herself with it, whether this takes place in courses, meetings, or in other venues (in this connection technology can be software, hardware, or a concept/idea). The teacher then progresses in the second phase to using the technology tentatively, though without the technology as yet becoming a permanent fixture of his or her practice – "at least I gave it a try" is a typical description during this phase. A breakthrough occurs in phase three, when the teacher starts using the technology for specific purposes. In phase four the teacher recognizes that new technology alters the educational framework and adjusts his or her teaching accordingly. In phase five the teaching becomes more pupil-focused and the teacher recognizes that technology and practice are dynamically intertwined.

Hooper and Rieber's model implicitly assumes that the teacher progresses from phase one and upwards in the hierarchy. How quickly the teacher develops depends on various factors such as previous experience, skills, and motivation. It is by no means given that everyone reaches phase five in all contexts – Hooper and Rieber contend that most teachers, as of 1995, fail to advance

beyond phase two. Today there is reason to believe that more teachers progress further than that, even though teachers will not necessarily consider all technology to be equally relevant and useful and will thus not evolve their practice to the highest level.

Activity theory

Leont'ev (1979) claims that all activities are special and refer to a specific need of the active agent: "It moves toward the object of this need and it terminates when it satisfies it. Also, it may be reproduced under completely different circumstances." (Leont'ev, 1979: 59) He argues that it is the need that governs the activity, and that the activity dissolves when the goal or the need has been achieved. Leont'ev states furthermore that it is the activity's object that separates activities from one another and that is the real motive. The motive can be either material or immaterial, but there can be no activity without a motive (Leont'ev, 1979: 59). Leont'ev also divides activity into several components, with actions that are linked to goals and operations that depend on various conditions. It is therefore possible to perform the same action with several different operations (Rønning, 2009).

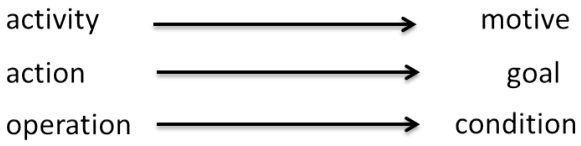


Fig. 2. Leont'ev's concepts of activity, action, and operation

Leont'ev uses an example concerning food. If someone wants to procure food, that is the motive for the activity. In order to achieve this, the person in question must perform certain actions with the ultimate goal of procuring food. Actions in this sense include the development of equipment or tools that lead towards achieving this goal, and the use of these tools is an operation.

Yrjö Engeström (1999) has expanded the model so that it can also explain an action's social and collaborative aspects (see Figure 3):

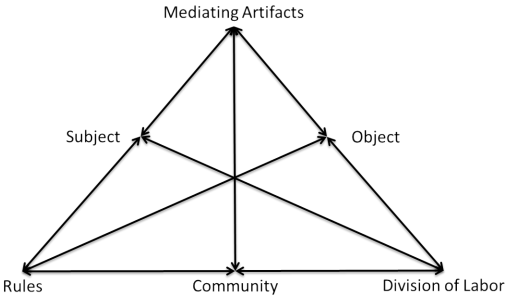


Fig. 3. Engeström's expansion of activity theory

This model not only helps us analyse contradictions and tensions between the original elements, it also enables an analysis of the context and the framework within which the activity takes place.

Interactive whiteboards in activity theory

Several researchers have used activity theory as an analytical tool both in math (Rønning, 2009) and even more so in the use of ICT (Karasavvidis, 2009; Krumsvik, 2009) and interactive whiteboards (Zevenbergen & Lerman, 2008). Zevenbergen and Lerman's analyses of the use of interactive whiteboards in classrooms are based on Engeström's (1999) interpretation of activity theory. In this line of analysis, the pupil is the subject. The mathematical topic and the goal of the lesson constitute the object in Figure 3, while the interactive whiteboard and the software are the mediating artefacts.

The learning area is the community where the rules mediate the subject. The lesson's object will also depend on the community and the division of labour. There will thus be rules that one must adhere to in the community. The division of labour will be a means of achieving the lesson's object and thereby create a desired outcome for the activity.

In activity theory, interactive whiteboards and software can be seen as mediating artefacts, both through the whiteboard as a traditional blackboard and through the tools that are included in the software. In our project we investigated the possibilities these tools have for being mediating artefacts. Zevenbergen and Lerman (2008) studied how such software influences the planning process in education, and Holmes (2009) conducted a similar study on how student teachers prepare their teaching. According to Zevenbergen and Lerman (2008), teachers are positive to readymade teaching plans that are available on various web sites. One teacher stated that he would go out and find good, readymade teaching plans and that he was certain that such plans had been quality assured. Other teachers they interviewed claimed that time could be saved in planning and execution because all the basic resources (such as calculators, rulers, clocks, and so forth) are available in whiteboard's software. This is something that might help motivate pupils (Zevenbergen & Lerman, 2008). Readymade figures, for example various representations of fractions, enable the teacher to create a more rewarding learning environment for the pupils.

The interactive whiteboard seems to replace the traditional blackboard, in many ways because it is possible to teach in largely the same manner as before: pupils can go up to the whiteboard to make a presentation or to solve a task, and it is also possible for the teacher to start with a blank board and write on it in the course of a lesson, in the same manner as with the traditional blackboard. According to Zevenbergen and Lerman (2008), having pupils work on tasks on the whiteboard might be a challenge because not all pupils enjoy having their work displayed to the entire class.

Division of labour is a key aspect in activity theory. How might an interactive whiteboard influence the division of labour in the classroom? In the classes that Zevenbergen and Lerman (2008) observed, the tendency was for the teaching methods to be traditional, that is, the teacher controlled the whiteboard while the pupils sat on the floor in front of it; the teacher presided over the lesson and decided both which pupils could participate and when they could do so.

In Engeström's (1999) model, the community is comprised of the people with whom one surrounds oneself. An example could be that the class and the teacher constitute a community, but other teachers and the school administration can be members of the same community. The community is governed by rules that change from one community to the next. In schools, for instance, the curriculum and the textbook constitute some of the rules; another example is the rules that the teacher and the pupils have agreed should apply when pupils work either individually or as a group.

Motivation

Knezek and Christensen (2008) believe that the successful employment of computers in the classroom depends on positive attitudes to computers. This statement suggests that it is important to show consideration to pupils' attitudes to and motivation for using technology in learning activities (Ainley, Enger & Searle, 2008; Knezek & Christensen, 2008). Over the past twenty years, goal orientation has evolved to become a key motivation theory. Traditionally, the theory of goal orientation has emphasized individual approaches to learning (Elliot, McGregor & Gable, 1999; Midgley, Kaplan & Middleton, 2001).

Ames and Archer (1987) differentiate between the concepts of *mastery goal* and *performance goal* to describe an individual's focus for participating in a given activity. By "mastery goal" they mean that the individual performs an activity because he or she wants to learn as much as possible, while "performance goal" indicates that the individual is focused on the result of the learning process, for example a test, exam, or other type of competition.

Individuals with performance goals will focus more on how they are doing and how they appear to others. In contrast, individuals with mastery goals are more task-oriented and focus more on personal growth, mastery, and learning in accordance with individual standards. Pupils with mastery goals can be described as being positive in regard to the use of learning strategies and willing to spend more time and effort on learning activities, so that they show greater perseverance in completing learning activities (Elliot & McGregor, 2001; Pintrich & Schunk, 2002; Darnon, Harackiewicz, & Butera, 2007).

Classroom management and planning for educational design with a focus on communication

Working with an IWB in the classroom depends on several criteria in order to increase the possibility of learning in the classroom. One of the most challenging aspects of teaching is to achieve a dialogic interaction and establish a level of cooperation with the pupil. Schoolwork should ideally have a continuous, cumulative quality (Alexander, 2006, 2008) where activities and goals are part of a larger totality, and where the schoolwork is more or less a goal-oriented educational and dialogic journey with language and IWBs as mediating artefacts. But it is of course not only by participating in the classroom that pupils acquire knowledge and understanding. This must be actively followed up through the use of appropriate learning strategies and communication or dialogic teaching (ibid.). Learning strategies become what pupils use to structure their own work, regardless of whether they listen to a lecture, participate actively in a dialogue, or work alone or in groups. Learning strategies can be an aid for the teacher to discover who is actively listening and connecting the subject matter to their pre-lesson knowledge. The question here is whether the teacher as class leader has planned the lesson so that the interactivity on the board is dictated by teacher–pupil dialogue rather than by monologue. This underlines the necessity of planning in accordance with pupils' knowledge of themselves and their own learning strategies.

In a classroom study (Helgevold, 2011), teachers and pupils were both observed and interviewed. One of the areas of investigation was whether the traditional blackboard was used as a tool for dissemination or as a mediating artefact in teacher–pupil communication. One of the teachers describes such a board as a useful tool for brainstorming and for writing down the key points that the pupils need to know to progress in their learning. One of the pupils in the study differentiates between good teachers, who both write and communicate, and the other teachers, who merely write for the pupils to copy. The board is described both from a traditional and a more sociocultural perspective, but always as the teacher's tool (ibid.). When progressing from this type of board, teaching, and pupil activity towards an interactive whiteboard, we would expect a board that goes from being the teacher's tool to being a common tool, that is, a mediating artefact where both teacher and pupils participate in the teaching. What happens, then, when new tools such as IWBs (interactive whiteboards) are in fact incorporated in the classroom? Does this influence the planning, so that the teacher's educational design develops more towards new forms of communication, pupil learning, and classroom interactivity?

The transition from a traditional blackboard to IWBs requires the teacher as class leader to think differently in regard to his or her educational design for classroom teaching. Otherwise the teacher runs the risk of ending up in a similar situation to the one Elisabeth H. Mohn (2008) refers to in her teaching journal, where she says that she was typically in charge at the board, that significant pupil involvement with IWBs in this type of teaching seemed to have a negative impact on the teaching tempo, and that the pupils did not necessarily focus their attention. How

IWBs are used might reinforce traditional teaching and has led to concerns that whole-class technology might easily mesh with existing patterns of classroom interaction, and that the technology's effectiveness might reinforce presentational approaches and teacher domination, which in turn will reinforce traditional methods (Somekh et al., 2004: 25). International studies and observations show that IWBs can reinforce traditional teaching methods, and that a well-planned execution can quicken the pace of teaching, causing more pupils to lag behind (Somekh et al., 2004: 25; Mohn, 2008; Betcher & Lee, 2009; Lee, 2010). In that case it is crucial for the teacher to be aware of this and evolve his or her own teaching towards a more relaxed pace, pupil involvement, and good communication. Through their educational design of the teaching situation it is also important that teachers plan on how to advance interactivity in dialogue and board use. Such planning is important so as to avoid being co-opted by tradition, that is, avoid using the board in a traditional manner. Research shows that the impact of an IWB does not necessarily extend beyond the initial novelty attraction. A survey in South Africa, " Interactive whiteboards: Real beauty or just ''lipstick"?", found that teachers initially preferred a computer and a projector and that their IWBs were like lipstick – and something that could be used later on. One of the teachers in that project who had succeeded most in integrating the IWBs said that it was mainly the computer and the projector that made the biggest difference in teaching (Slay, Siebörger, Hodgkinson, Williams, 2007). As with all types of educational resources or technological tools, the vital element is what teachers actually do with an IWB – good teaching remains good teaching with or without technology (Murcia and Sheffield, 2010). Warwick and Kersner (2008) and Smith, Hardman, and Higgins (2006) also state that teachers need time and opportunity to think through new ideas and opportunities to try these ideas in practice. Ideally this should take place within a context where they can receive feedback from more experienced teachers and where they can develop professionally along with their colleagues.

As an element in their plans to integrate ICT into schools, the British authorities invested in a large number of IWBs, and 63 % of primary schools in England and Wales had an IWB already in 2004 (Becta, 2005). And the their belief in this tool was obvious:

"Education Secretary Charles Clarke has pledged to roll out interactive whiteboards to every classroom so the teacher's PC, including web pages and desktop applications, can be projected onto a screen visible by the whole class." (Arnott, 2004).

The only problem with this was that "the revolution" focused more on technology than on education (Gillen, Staarman, Littleton, Mercer & Twiner, 2006). Without strategies for school development and a more deliberate methodology, the technology can be more of a problem than a solution for better teaching and learning.

In their study of how IWBs can be used to orchestrate classroom dialogue, Neil Mercer et al. (2010) discovered that IWBs allow a great degree of flexibility in that they helped teachers

design good resources that stimulated the dialogue in the entire class. They also argued that IWBs provide new opportunities, but only as a servant for the pedagogy, not as the master. Another of their conclusions is that IWBs as a teaching tool are independent of both hardware and software. A similar conclusion was reached at Vestfold University College in the study "IWBs for teachers" – the critical element is the teacher's ability to engage the pupils and help them to learn. This must also be taken into consideration when teachers receive training in the use of IWBs (Karlsen & Wølner 2010; Mercer, Hennessy & Warwick, 2010).

In order to turn IWBs in the classroom into a tool for learning and not only for teaching, it is necessary to look at classroom research. One area can be what Robin Alexander calls, to quote the title of his book, *Towards Dialogic Teaching – Rethinking Classroom Talk*. This also means that we must take two different factors into consideration at the same time and look at both language/dialogue and IWBs as mediating tools, in which case dialogue becomes an important part of the learning area for the community in activity theory. Then it can also be necessary to have an analytical tool for the communication forms that take place within the activity in the learning work, so that the object's generated result is optimal. Before we take a look at the analytical tool for communication, we will describe Robin Alexander's five points for dialogic teaching (Alexander, 2006, 2008):

- The collective: teachers and pupils work together in the learning process, either in groups of pupils or as an entire class.
- The reciprocal: teachers and pupils listen to one another, exchange ideas, and consider different viewpoints.
- The supportive: pupils present their ideas freely and without fear that an answer is wrong, and help one another reach a common understanding.
- The cumulative: teacher and pupils continue to work with their own and other's ideas, and create a synthesis through reflection and questioning
- The purposeful: the teacher makes plans and facilitates dialogic teaching with an eye towards certain educational and professional goals.

We will look at dialogic teaching along with Phil Scott and Eduardo Mortimer's (2005) model, which differentiates between dialogic and authoritative communicative approaches. This means that a discussion can at the outset be either dialogic or authoritative, regardless of whether it is expressed individually or between people. That the discussion becomes functionally dialogic entails that more than one viewpoint and idea is examined and developed. Scott and Mortimer believe that the division between dialogic and authoritative discourse is part of the discussion can be dialogic or authoritative at the outset. In that case it is independent of whether it is expressed individually or between people. What makes the discussion functionally dialogic is that more than one viewpoint is represented and ideas are examined and developed, more than that it is produced by a group of people or by a single individual.

In this context Scott and Mortimer created a table in which they identified four classes of communicative approaches; this table can be useful for analysing communication concerning the use of IWBs in the classroom. Murcia and Sheffield (2010) expanded the table and added "many voices, one voice, many ideas, and one idea", in order to expand and simplify the work on analysing classroom dialogue and the use of IWBs (see Table 2).

Table 2. Four classes of communicative approaches (Scott and Mortimer, 2005; Murcia & Sheffield, 2010)

	Interactive Many voices	Non-interactive One voice
Dialogic Many ideas	**A** Interactive/dialogic Many voices and ideas	**B** Non-interactive/ dialogic One voice and many ideas
Authoritative One idea	**C** Interactive/ authoritative Many voices and one idea	**D** Non-interactive /authoritative One voice and one idea

Murcia and Sheffield also conclude that IWB technology is only as effective as the classroom teaching allows, and they state furthermore that teachers need support when they integrate digital tools in the classroom (ibid.). In the analysis of our project, the following points have serves as the basis when analysing the transcriptions:

Communication and the teacher who "sees" his or her pupils are important factors for adapted education as well. Many factors influence the pupils' learning, with pupil interaction being the most important factor (The Norwegian Department of Education and Research, 2008). Pupils use language to clarify and discuss subject matter when they use IWBs. Some have solid language skills, while others are in the process of developing their linguistic awareness. The classroom features children with different skill levels and "different voices". Language is the most important tool mankind has to collaborate and create meaning (Nevøy, Moen, & Ohna, 2007). Vygotsky's ideas are important because he highlighted the importance of communication and collaboration in activities. Learning is not an individual practice, but is distributed between people in collaboration (Lave & Wenger, 1991). Vygotsky's main argument concerns how we form higher psychological processes. Language and writing with signs and symbols are examples of higher psychological processes. Social activity mediates higher psychological processes, and such processes are supported and strengthened in interaction with others.

We can borrow one another's knowledge and use it as our own (Säljö, 2001). Our voice – what we say – is influenced by our surroundings. Wertsch (1998) emphasizes this by referring to a statement of Bakhtin's that "the word in language is half someone else's". Bakhtin's theory on how language creates meaning highlights the importance of how our own development is also determined by the activity of others. It is therefore important study communication and our use of language when using IWBs.

Empirical data

One of the key features of Norwegian education is that schools are meant to even out social inequality. There is an explicit goal of a comprehensive school where all the pupils enjoy equal opportunities for learning and growth. When introducing technology in the schools, for instance with the acquisition of IWBs, there is also an expectation that the use of IWBs shall lessen any digital gap among the pupils.

In this section we will review our findings from the project school in relation to the four concepts of access, use (the teacher's role, communication, evaluation, and educational design), technical skills, and learning through IWBs.

The many faces of dialogue in the classroom – observations and analysis of the Norwegian classroom

Good teaching leads to change; very good teaching can change lives (Hofkins & Northen, 2009). Good teachers typically have a solid command of their field and a broad repertoire of teaching methods and learning strategies, which they know how to implement for effective teaching and learning. In this context we have highlighted examples from our empirical data that can shed light on communication forms and dialogue, so that can thereby use the analysis to make further strides towards excellent teaching. We have split the data into episodes, each featuring a concise introduction of the topic, excerpt from the transcript, and a brief analysis.

Episode A: Norwegian lesson, November 2010 (topic: prepositions)

The topic for the Norwegian lesson that day was prepositions. The teacher introduced the topic without using the IWB. She then removed masking tape from the text on the IWB, where she presented the lesson's achievement criteria; the pupils were then asked to open their textbook. The pupils were handed a written note explaining what a preposition is, and they began their work by gluing this note in their workbooks. The teacher informed the pupils of certain practical issues regard the textbook and the rules; the rules were also written on the IWB. When teaching and when engaging in dialogue with the pupils, the teacher used the textbook in order to show a framed summary of prepositions.

TEACHER: Okay, page 190. What does it say there? Shhhh...
TEACHER: Can you read aloud, Peder (?), what it says in the little red box on page 190?
PUPIL (citing a list of prepositions): Av, etter, fra, gjennom, da, innen, med, mellom, på, hos, i, ved, for, foran, mot, om….
TEACHER: Yes. Can anyone explain what innunder ["beneath, underneath"] means? Can anyone say a sentence that includes innunder?
TEACHER: Petter (?)?
PUPIL: The rat crawled underneath the house.
TEACHER: Yes. Another example with the same word? Kristian (?)?
PUPIL: Ehh, I can't think of anything…
TEACHER: Ehh, Fride...
PUPIL: I put my tooth underneath the pillow.
TEACHER: Yes, I put my hand underneath the pillow.
TEACHER: But, under.. The rat crawled underneath the sweater… if you have a rat as a pet… underneath… up and through…

Analysis

The dialogue in the lesson started as a monologue –a non-interactive and authoritative dialogue with one voice and one idea. In other words, in this situation the teacher (Linda) used the most traditional form, sender to receiver. Many lessons start in this way in order to clarify both the object and the objective of the lesson, something that is probably most expedient and practical for the teacher. In our opinion, pupils might find it difficult to see the point of a presentation through a non-interactive dialogue with only the teacher's voice. As long as the dialogue is non-interactive and authoritative, it is hard for pupils to see that it is they themselves as individuals who are to choose the achievement criteria. If there is no possibility of a more interactive and authoritative dialogue with many voices, or optimally interactive and dialogic, pupils will be given achievement criteria rather than writing or choosing them themselves. However, a deliberate choice of achievement criteria will provide a greater sense of ownership, and thereby a greater possibility for reflection and self-evaluation afterwards – "What have I learned?"

In the next loop one of the pupils read prepositions from the textbook, without the IWB coming into play; that is, up to that point the IWB was used as a traditional blackboard. In contrast, the classroom dialogue was in flux and changing its form, from being at first a non-interactive and authoritative dialogue and then gradually evolving into an interactive and authoritative phase, starting with the closed question "Can anyone explain what *innunder* means?" – it then became an interactive and authoritative dialogue with a given answer (an idea). In the next loop the teacher and the pupils moved toward the interactive and dialogic area; more voices were heard from, and many ideas were expressed. The teacher achieved this quite simply by asking a more open-ended question ("Can anyone say a sentence that includes *innunder*?") – the pupils then experimented with the word *innunder* in several variants and made proposals.

It became a continuous movement where the dialogue moved from quadrant to quadrant in the dialogic axes system within the circle – not unusual when the teaching goes in loops within a topic.

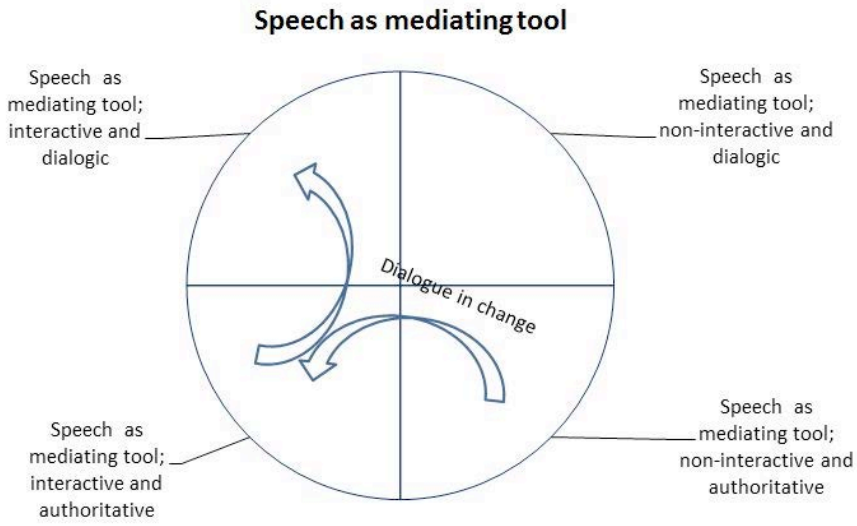


Fig. 4. Wølner (2011), based on Scott and Mortimer (2005)

If we examine the same episode in regard to the interactive whiteboard, we see that it was static and non-interactive/authoritative, given that it contained only one voice and that its omnipresent idea was an explanation of what prepositions are. It did not facilitate a greater degree of interactivity; the board remained as yet the teacher's tool and was static in its usage.

Episode B: Math lesson, May 2011 (topic: the circle, pi, and the area of a circle)

The teacher's goal for this lesson was that the pupils were to review basic concepts concerning the circle, such as radius, diameter, and so forth. A further goal was to introduce pi (π) as a new concept and that pupils should learn to calculate the area of a circle. Figure 5 shows how far they had come prior to the lesson.

In this phase of the research project it was decided that the teacher and the researchers should plan the lessons together and start to collaborate on a good educational design – that is, the researcher participated as a partner and mentor in the planning and in post-lesson discussions. The intention was to follow up what also Murcia and Sheffield (2010) pointed out after conducting their research project on the use of IWBs in natural science lessons, namely that teachers should get support when they plan to integrate new technology in daily classroom practice. In our research project this was to be carried out in accordance with ideas from the

"lesson study" method (Lewis & Hurd, 2011). In short, this means that all the planning participants are co-responsible for the teaching and thereby also for the revision work before the next lesson, if such revision is necessary. We were to collaborate on forming the educational design for the lesson, and all members of the group were equally responsible for teaching and classroom management.

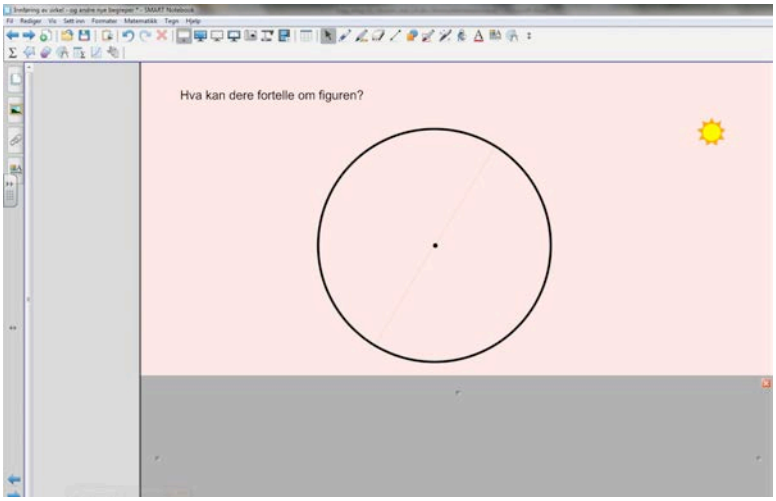


Fig. 5. The circle displayed on an IWB at the outset of the math lesson.

TEACHER: What can you tell me? [The teacher points to the circle that is displayed on the interactive whiteboard.] Martine?
PUPIL: It is round.
TEACHER: It is round. That's a good place to start. What do you mean by "round"?
PUPIL: Me?
TEACHER: Yes. You can define it.
PUPIL: Because it does not have sides.
TEACHER: No sides. Good. Tone.
PUPIL: ... and then there is that dot that also doesn't have sides. That dot.
PUPIL: ... and then you said that it is...
PUPIL: ... did not have sides...
TEACHER: And then you said something more. "It is." You said something, and that's what I want to hear.
PUPIL: It is – there is a dot in the middle.
TEACHER: In the middle, yes. And what does it mean that it is in the middle?
PUPIL: In the middle of the figure.
TEACHER: Mmm. Can du explain to me what it means to be in the middle of the figure. [The pupil seems unsure of the question.] ..... But you know what it is. We need this to be explained a bit more.
PUPIL: It is the centre.
TEACHER: That's a good word to use. Indeed. It means exactly the same thing. The middle or in the centre.

Analysis

In this loop we clearly see where the dialogue is in regard to the quadrants in the axes system for mediation through language. At the outset we also see an interactive whiteboard, which is ready to be placed in the same quadrant as language. In other words, in this case we would also have a simultaneous mediation through both language and an IWB, as shown in Figure 6.

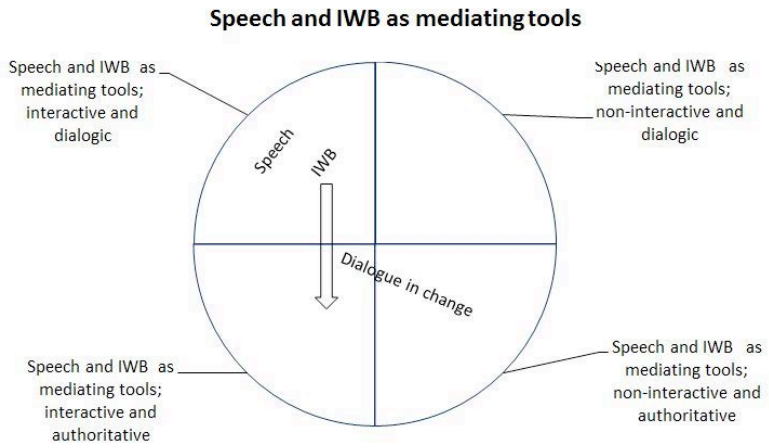


Fig. 6. Wølner (2011), based on Scott and Mortimer (2005)

In this situation we could have achieved a maximum exploitation of the mediating tools, if both tools had remained in the interactive and dialogic quadrant. This would have been a natural conclusion if we only looked at the transcript, but classroom observation revealed another picture, because the circle also here became the teacher's property – that is, the teacher did not make use of the situation, and the use of the IWB became part of the interactive and authoritative dialogue. It was only the teacher who used the board, in an otherwise excellent lesson with good teacher–pupil interaction. It is merely our assumption that opening up the IWB to become "common property" would have improved the teaching, but certain statements that pupils made during our interview with them do suggest that such a strategy could stimulate even better teaching and learning. One of the pupils stated the following in regard to participation in math class and the use of the board (we come in at the point where the interviewer asks about changes regarding the use of Smart Boards in class):

> *INTERVIEWER: Are there other things that have become different, other than that you get to use the Smart Board more and that it has become easier to use it? Is there anything the teachers so differently – something about the classes that has changed?*
> *PUPIL 3: No. Or yeah, sure, perhaps some have become smarter.*
> *INTERVIEWER: Become smarter?*
> *PUPIL 4: Yes.*
> *Pupil 1: Well, at least I myself became a bit smarter in math.*
> *INTERVIEWER: You became a bit smarter in math?*
> *PUPIL 1: Yes.*

The pupil does not say anything about actively using the IWB, but clearly expresses that the teaching has changed in nature, and that he has become smarter in math.

In the math lesson, the teacher drew a circle on the IWB and wrote the question, "What can you say about the figure?" – an entirely open-ended question that enabled all the pupils to participate. There was space to answer, and we are here within Robin Alexander's five points on dialogic teaching (2006, 2008): there is space for many voices and many ideas, and there is at the outset no fixed solution. Everything is allowed, as we see from Martine's answer to the question: "It is round." The lesson then continued in that manner, with the teacher and the pupils remaining in the interactive and dialogic quadrant. All the voices in the class were included, and many ideas were expressed.

Episode C: Math lesson, May 2011 (topic: circles, pi, and the circumference of a circle)

Following the repetition from the previous episode, the loops progressed to teaching and instruction. The teacher discussed pi and how the number 3.14 came to be. The pupils also engaged in practical work on why pi is approximate to 3.14, and the pupils and the teacher solved the problem together. As shown below, the transcript then shows a loop where pupils work together in pairs, before moving on to a teacher–pupil dialogue on the circumference:

> *TEACHER: Do we know the rules now? [The pupils answer yes]. Now we are going to use them. I have created a problem now that you can sit together with your usual partner and think about. What is the circumference if the diameter is 5 cm? [The problem is displayed on the IWB.] Discuss this with your partner.*
> *PUPIL: Monica, I solved it. Is it 15.5?*
> *TEACHER: Very close.*
> *PUPIL: Is it 15.7?*
> *TEACHER: Can you come up here and show how it's done?*
> *TEACHER: Is there anyone here who volunteers? You're the first. Can you come up here and show how it's done?*
> *PUPIL: I had my hand in the air the entire time.*
> *TEACHER: Sorry. I'll keep that in mind.*
> *PUPIL: I took it [writes with a pen on the IWB] and reversed it.*
> *TEACHER: Why?*
> *PUPIL: Because pi equals 3.14.*
> *TEACHER: Tell me what you did.*
> *PUPIL: I took 5 times 4, which is 20 – carry the two – and then I took 5 times 1, which is 5, and 5 times 3, which is 15.*
> *TEACHER: Very good.*
> *[The pupils clap.]*

Analysis

In this loop the pupils used pi and rules for calculating circumferences. The pupils were in a collaborative phase and an interactive and dialogic dialogue on the pupil–pupil level, before the teacher again took over and guided the pupils into the sociocultural classroom environment through interactivity, open-ended questions, and the sharing of the IWB.

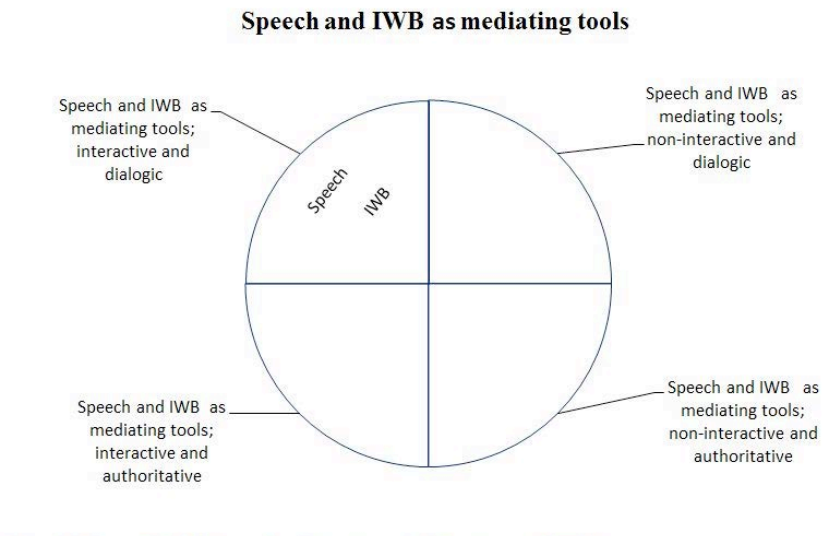


Fig. 7. Wølner (2011), based on Scott and Mortimer (2005)

The pupils were again in the same quadrant with mediation through language and the IWB. In this quadrant you are allowed to reflect on and conceive of several ways of solving the problem – it is an arena for a variety of ideas. We noticed in particular that the teacher asked later on, “Did anyone else arrive at the correct answer, but in another way?”

IWBs for subject learning

We have chosen to differentiate between the technical challenges of IWBs and the use of IWBs for subject learning. The reason for this is that it is necessary to master IWBs in order to use them to improve the learning. This is a two-step model, where step 1 involves mastering the technology and step 2 involves using the technology to learn a given subject.

Fraction notation

After initially denoting fractions by e.g. 1/2 instead of $\frac{1}{2}$, the teacher commented later on that she had managed to denote fractions in the traditional manner.

Fig. 8. Various representations of a fraction

In the example below, we see that it is possible to misunderstand the problems because of the given notation. Pupils were supposed to calculate $\frac{1}{2}+\frac{2}{3}$, but on the whiteboard the fractions were written "1/2 + 2/3". One pupil, after doing the math and finding out the answer was seven-sixths, expressed surprise when another pupil dragged and dropped 1 1/6 and asked the other pupil why he had answered eleven-sixths. The other pupil clarified that 1 1/6 meant a whole and a sixth.

The example illustrates that educational problems can arise when the notation used on the IWB differs from that used in the textbooks and by the teacher during the lesson.

Pupils playing Fraction Racer against the clock

The pupils worked with math problems from the web site matematikk.org, playing a game called "Fraction Racer" (*Brøkreser*). According to the game's instructions, "If you're fast enough in calculating fractions, you'll win a gold medal on your certificate!" Fraction Racer gives pupils practice in calculating fractions and tests their mettle in other types of fraction problems as well. It seems as though the fraction problems were intended to be solved on computers, but during this lesson an interactive whiteboard was used.

In the lesson in question, the pupils worked on common denominators. As a math tip, the teacher stated that with numerically close denominators, one strategy for finding the common denominator would be to simply multiply the denominators. The teacher also informed the pupils that the less time they spent on solving each problem, the higher their score would be.

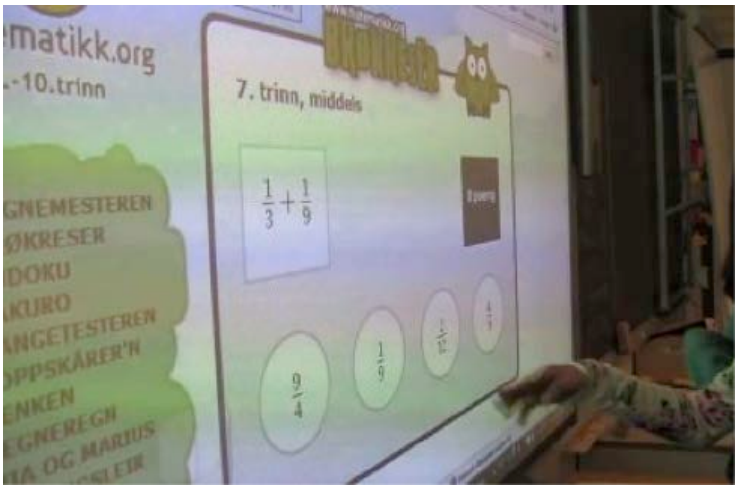


Fig. 9. Fraction Racer (*Brøkreser*) from matematikk.org

The pupils started the Fraction Racer game by opening the wrong problem, one that dealt with adding fractions rather than with finding the common denominator. The first problem was $\frac{1}{3}+\frac{1}{9}$, with the answer alternatives listed as $\frac{9}{4}, \frac{1}{9}, \frac{2}{12}$, and $\frac{4}{9}$. One of the pupils suggested multiplying the denominators with each other. The other pupils ignored her strategy and chose $\frac{2}{12}$, apparently adding the numerators together and the denominators together; the game deducted two points as a result. Another pupil stressed the situation by exclaiming, “Oh, come on, hurry up!”, because he knew they were racing against the clock. After the group had finished solving the problems, this pupil was mostly concerned with the group’s final score, while the other group members were more interested in replaying the game. After a while one of the girls turned to some of the others in the class and demonstrated with her arms how they had merely pressed wildly on the board.

One of the boys in the group rounded off the session by informing the teacher that all they had done was frantically press the screen. The discussion afterwards in the group dealt mostly with what had happened, and not as much about why they had failed to answer more answers correctly or which method of calculation they had used.

Analysis: Pupils playing Fraction Racer

In the episode “Pupils playing Fraction Racer”, the teacher’s goal was for the pupils to collaborate in front of the whiteboard in order to learn about common denominators. Our assumption here is that were tensions between the teacher’s and the pupils’ differing goals, as the pupils’ goal seems rather to have been to win the game. This affected the dialogue around the board: when a pupil interjected “Oh, come on, hurry up!”, this might indicate that he felt stressed because the clock was running.

It is the software that becomes the artefact or the tool here (Engeström, 1999). The pupils experienced Fraction Racer as a game with time limits, something that affected the object of the activity. The important aspect for the pupils became to finish the game in the shortest amount of time and achieve the highest number of points. The points were continuously updated, but our observations suggest that the pupils did not place much emphasis on these intermediate scores – the group simply moved on even when Hans pointed out that they had been deducted two points for an incorrect answer. The pupils' goal also meant that another type of rules entered the classroom, namely the type of rules used in games. There was little collaboration among the pupils, who focused instead on getting through the problems as quickly as possible; Emil was also concerned with counting the points that were awarded. The group was aware that they did not follow the rules that normally apply in the classroom. This became apparent when Theresa commented to some other classmates that her group was only pressing the screen without looking, and when Emil informed Mona that they were only pressing wildly. Since the problem sets dealt with common denominators, they should have served as a tool for the teacher to achieve her goal. It seems, however, as though it was the game aspects that caused the tension to mount. The time factor resulted in the pupils focusing more on answering in the shortest amount of time rather than collaborating and helping one another.

The dialogue among the pupils also pertained less than to the subject at hand than was the case in the other episodes. When the pupils did use mathematical concepts, for instance when Jørgen pointed out that they were not multiplying, the other pupils in the group did not follow up. Pupils also used the wrong method when adding two fractions – it occurred several times in this example that the pupils merely added the numerators together and the denominators together (Nordberg, 2002). In other words, a jumbling of various algorithms took place. Mona had taught her pupils that if two denominators are numerically close, for example 7 and 8, then one strategy is to multiply the two numbers in order to find the common denominator – it was perhaps this information that led the pupils to mix the algorithms.

Help from the front row

The following example shows how a pupil who worked on the whiteboard made use of the fact that the other pupils could see the problem he was working on. When the teacher was not present at the whiteboard, he asked the pupils who sat on the front row for help.

One of the math problems dealt with certain merchandise being marked down by 10 % – the question then was what percentage the customer had to pay. One of the pupils then helped him to calculate this, answering, "You have to take 100 per cent minus, minus whatever it says there [*the pupil refers to the tag near the items*]." He then started to solve the problem, and it seemed as though he saw the connection.

Analysis: Help from the front row

In this example the whiteboard served as a tool that allowed Frank to work with math problems, in this case fractions and percentages. The new element was how Frank used the whiteboard to get help from others when he was stuck. The empirical data is insufficient to assess whether Frank learnt anything in this session, though it can be noted that he did answer many of the problems correctly. He also seemed to be motivated by this, because he gave Mona intermittent updates on his progress. The first problems were fairly easy, and that might have been one of the reasons things went so well. On the other hand, Frank solved more difficult problems later on with the help of his classmates (Dysthe, 2001; Hauge, Lund, & Vestøl, 2007).

In this example Mona, the math teacher, did not concentrate much on the technical usage of the board. That might be because Frank is skilled in the use of the interactive whiteboard, as gauged by Erstad's (2010) factors. Frank accessed the keyboard and navigated and oriented himself on the board with ease. Mona could therefore concentrate on acting as the math teacher. It is interesting, however, that Mona chose to use the traditional blackboard when going through and explaining the problem to Frank. This can again be seen from two perspectives: on the one hand, it might be because Mona knew that the pen tool in this case would activate an ink layer and therefore not be as expedient; on the other hand, it is likely that Mona felt more familiar with the traditional blackboard and therefore chose it first.

The interactive whiteboard was a tool that both motivated Frank to work with math and became a way for Frank to receive help from his classmates, without them having to leave their own workspace. The other pupils' actions then become a tool for Frank to achieve his goal, and he involved them in his activity system and his learning – similar to Vygotsky's zone of proximal development (Dysthe, 2001).

The use of IWBs in Norwegian lessons

This part of the report is based on observations of Norwegian lessons and interviews with pupils and teachers. The observation of the Norwegian lessons took place in three rounds. In the first Norwegian lessons we observed (November), the class worked on the runic alphabet and on grammar (word classes). In December we also observed work on grammar (word classes) and station teaching pertaining to subject matter from the curriculum. In May we observed Norwegian lessons that dealt with strategies for reading.

Observation 1: IWBs used in grammar lessons

The interactive whiteboard was used throughout all the grammar sessions we observed. The teacher had created a presentation as a Notebook file that introduced the new material and presented problems for the pupils to solve. The topic of word classes was reviewed in a teacher-led conversation that used both the textbook and the presentation on the whiteboard. After going through the new material, the pupils were to use what they had learnt to solve the problems. The

pupils first worked individually on the problems, before each pupil went up to the whiteboard and entered the correct answer.

The final grammar session we observed was a review of the autumn semester's grammar lessons. The teacher had made a multiple choice test that encapsulated the topics that the class had been through. The pupils first paired up to go through the topics, before individually answering a multiple choice test using Smart Board's response system. The teacher had created a Notebook file with a question page. The teacher showed one question at a time, read the question for the pupils, and proceeded to the next question when all the pupils had answered the question.

Analysis

The teacher's role

IWBs were used in the grammar sessions to introduce new material and review/round off the work (the multiple choice test). In this review session, the teacher's role was relatively traditional, with the teacher switching between presenting the material and leading the discussion.

Educational design

For the grammar sessions the teacher created Notebook files herself. The teacher varied between using the whiteboard to introduce new material and to discuss with the pupils. She also had a plan for when pupils were to take notes from the board, and pupils received copies of a slide that contained especially important information. When the pupils were to solve problems from the board, the teacher had allotted time for individual problem-solving before the pupils were allowed to go up to the board.

When summing up the autumn semester's grammar lessons, the teacher created a multiple choice test that the pupils were to answer via the IWB's response system. The system displayed one question at a time, and the test did not proceed until all the pupils had answered. This test method was overly time-consuming: many pupils were forced to wait between questions, and the teacher had to exhort the pupils to answer quickly. The teachers reflect upon this in the interview, stating that some of the pupils found the test somewhat tedious because it took a long time and they had to wait a while. The test pace can thus be a challenge when using the response system when testing the entire class. Another challenge is that the test problems must be formulated such that there are alternative answers. The teachers reflect upon this in the interview. They highlight the importance of having several alternative answers, because such alternatives ensure that the pupils must make up their mind about what is the correct answer. They have also experimented with including more than one correct answer, because that requires greater reflection from the pupils.

The pupils as well were concerned with the use of the response system in tests. Pupils in one group interview stated that they felt that such a test method helped motivate them, but they were also aware of the possibility of merely guessing the correct answer: “Sure, you can guess. Either you got it right or you didn’t. (…)”.

Communication

For these sessions the teacher prepared the teaching and the Notebook presentation in advance. The advantages of such advance preparation were highlighted by both the teachers and the pupils. The teachers stated that they felt they had been able to structure their lessons better, and is noteworthy that the pupils shared this assessment. The pupils also stated that it is easier to read the IWB, not only in regard to its inherent legibility per se, but also in regard to other factors: for instance, the traditional blackboard had to be erased with a wet sponge, something that in turn made it difficult to read subsequent writing. In an interview one of the pupils reflected on the difference between traditional blackboards and IWBs: the pupil stated that IWBs increase the pace because further text can be added without first having to remove previous text with a sponge, and that a pupil can return to the text if he or she has not jotted it all down.

Evaluation

The grammar sessions used different forms of evaluation. The one session was in its entirety an evaluation, where the pupils were to sum up the semester’s work through a multiple choice test. Multiple choice tests can also be carried out in other ways than by using IWBs, and can be done individually, whether on paper or on a computer. According to the teachers, however, pupils seem more motivated for tests when they use the response buttons and look forward to the Friday tests because the IWBs are more fun and provide immediate feedback. In the interviews the pupils also state that it is more fun to use the response buttons than to write on paper.

In the grammar session where new material was introduced, the teacher included the achievement criteria in her presentation, and the pupils were to evaluate themselves by using those criteria; this time the pupils wrote their self-evaluation in their exercise books. The IWB became thus a way to highlight the educational goals and criteria, and it was easy to access these goals and criteria at the end of the session when they were to assess their work. During one session, where the pupils were in the middle of working on prepositions, the pupils were asked to evaluate whether they understood prepositions by turning their thumbs up or down. Pupils with their thumbs turned up were instructed to continue working on the problems in the textbook; pupils with their thumbs turned down were to work on the problems on the IWB. The IWB was thereby used to adapt the education on the basis of the pupils’ self-evaluation. We observed then that the pupils started discussing among themselves: only two pupils had initially shown thumbs down, but when the others realized that these two were going to be allowed to “have fun” on the IWB, some of them also claimed that had shown thumbs down. The challenge in such adapted

education is knowing who has a genuine need for such facilitation and who is “feigning” in order to use the board.

Observation 2: IWBs used when working on reading strategies

During the spring semester we observed the use of IWBs in lessons on reading strategies. This was a topic that the pupils had worked on previously (also at lower grade levels). The pupils were partly to review what they already knew and partly to acquire some new reading strategies. The first lessons started with the teacher communicating the lesson’s focus and goal, related to what the pupils knew of the topic beforehand. This was followed by a repetition of what they had learnt during the previous session. A presentation (Notebook file) was used for this purpose, and the pupils were to copy down some sentences from the presentation in their exercise books. This was followed by problem-oriented teaching and a subsequent discussion. After the problems were presented on the IWB, the pupils worked on them individually in their exercise books before reviewing them as a whole class. During the review some of the pupils were allowed to go up to the IWB and enter the key words. Then the teacher would pose a question as a means of sparking off a discussion with the pupils, resulting in a few tentative discussions related to concepts. The teacher went through each problem before a new problem was introduced, with the pupils working as before.

Analysis

The teacher’s role

The teacher created Notebook presentations for all the sessions, something that entailed some preparatory work for the teacher. The teaching varied between teacher-led instruction and problem-solving with the teacher as an advisor. The teacher’s role was more or less the same in these sessions.

Educational design

The observed sessions on reading strategies were fairly similar, a combination of teacher-led instruction and problem-oriented teaching. The problems were solved individually in the exercise books, followed by a whole-class review – some of the pupils were allowed to write on the board, but the review was primarily a discussion with the pupils regarding the use of certain keywords.

In one problem the pupils were to retell a given text on the basis of certain keywords. One of the pupils was tasked with writing his keywords on the IWB before retelling the text. This took a fair amount of time, and many pupils sat passively while this transpired.

Communication
The communication in the review sequences was teacher-led, with the teacher asking questions and the pupils answering. Some of the questions had an expected answer ("a solution"), others were more open-ended and allowed for a variety of answers. There were tentative discussions on the concepts, but not much time was allotted for such activity since the pupils were to go through many problems.

Evaluation
Some of the classes were rounded off with a summary of what the pupils had learnt in the class or what they had reviewed that day, without necessarily much focus on the achievement of the objectives.

Summary
We observed the use of IWBs for various topics in Norwegian lessons. What these lessons had in common was that the teachers used self-made presentations as a point of departure, and that these presentations were prepared in advance. Both teachers and pupils stated that this resulted in more effective lessons; the teachers also believed that their lessons became better structured, and the pupils felt that were able to go through new material quicker. Both teachers and pupils also emphasized that communication improved as a result, because the teacher did not stand with his or her back to the class when writing on the board. And according to both the teachers and the pupils, the IWBs helped intensify the pupils' concentration and focus. The classes we observed were largely quiet and focused, but we did not observe the classes when IWBs were not in use, so we are unable to make a comparison. The IWBs were used in a relatively traditional manner in these classes, and many of the elements could also have been done without an IWB.

The teacher's maturation
In our study we followed three teachers over the course of a school year. At the outset none of the three teachers had much experience with interactive whiteboards, though they did have some initial experience from the previous school year. Even though their initial skill levels varied, it seemed as though all three had entered or were about to enter the second of Hooper and Rieber's five phases: utilization.

There were several indications that all three teachers refined their own practice over the course of the project year, and in different subjects. One area that obviously pertains to the teachers' technological maturity is technical difficulties and how such difficulties are overcome. Several statements from the interviews reveal how the teachers became more self-confident with regard to the technology:

Linn: I sat there and made the response button test on Sunday evening, and I spent plenty of time. And when I had saved it and logged out and was going to log in again, Notebook stopped functioning with that document. So then I had to do everything over again. And that took a few hours.

This quotation is from the first interview, early in the project, and is typical for many of the statements, but also for many of our own observations at that stage. At the end of the school year the same teacher made several statements similar to the one as follows, upon being asked what she had become more proficient at:

Linn: Knowing what all the functions are used for and that I can quickly access things. I can access a network, a route network. (…). That it comes up quickly. That I don't have to search for so long before I can open what I want. So now it's like I feel I have a better overview of the whiteboard and I'm not so nervous.

Mona as well describes a thoughtful use of IWBs, where she is flexible and creative:

Mona: I feel that the Smart Board has in a way become a more natural part of teaching. (…) I feel that I have so much latitude in a way, and if there is anything I have overlooked during the planning, then I spot it during the lesson.

The teacher had in other words become more confident in her use of the Smart Notebook software. Also the pupils stated that the teachers improved over the course of the year:

Interviewer: What about the teachers? Have they changed somewhat in how they use it?
Pupil 4: Yes. Before they had no idea how to present stuff, but now I think they've become much better.
Interviewer: Did they fumble around with the technology?
The pupils: Yes [some giggling].

As they developed their own skills, the teachers started using more of the software and whiteboard functions. The teachers' statements correspond well with our observations from the classes, and there was a clear development in the teachers' lessons. Another area where the teachers showed growth was in didactic reflection. The teachers' thoughts about classroom use of interactive whiteboards vary in quality, with their initial descriptions being fairly vague and revealing an underlying belief that the interactive whiteboard might replace the traditional blackboard in the long run:

Linn: It makes things more visible for the kids when we use the Smart Board. They immediately get to see things there, as an immediate eye-catcher and centre of attention.
Interviewer: Exactly.

Linn: It is easier than having to write all the goals and achievement criteria and all that on the board [i.e., blackboard].

The initial conversations with the teachers usually revealed that they had not reflected much on interactive whiteboards, something that is not surprising when considering that the teachers had little experience with such technology. One year later the conversations evinced a much higher degree of reflection and evaluation. The teachers were critical and savvy and had clear viewpoints on their own practice:

Linn: Yes, I think so. I have had pupil activity that I didn't think was good, in regard to groups at the whiteboard who were supposed to work on problems that I had only scanned in. The ink layer that only kicks in then. So I have found that it has to be done in a different way. It's too disruptive then, I think. So it's also important that those preparations are good enough.

Adapted education

All pupils should be able to learn and grow in line with their own potential. They should experience a sense of community with others and grow as individuals, and they should learn the subject matter. Adapted education is a pervasive principle in the Norwegian school system. The Report to the Storting no. 31 (2007–2008), *Kvalitet i skolen* (Quality in the school), states that adapted education is an instrument whose purpose is to enable all the pupils, regardless of skills and personal circumstances, to exploit their potential for learning. The teacher is particularly important for each pupil's learning: John Hattie's (2009) major research study demonstrated that teacher feedback plays a key role in the educational development of pupils. What the teacher *does* is the most important factor for learning. Hence, how the teacher facilitates the pupils' work on and with IWBs is crucial. This conclusion is supported by statements made by the project teachers about IWBs and their own teaching, as exemplified by the following excerpts from our interview with them:

I now have a tool that helps me vary and switch methods. I can make more out of it.

…now I can use images or film from the web to make things more concrete, or show the lunar eclipse and things like that. It becomes more visual, not only something in a book. It's easier to illustrate things with that board [i.e., the IWB].

I think in a way you are able to reach more of the pupils than you do with the old chalkboard. I notice that pupils who normally didn't say anything are more in the swing of things now.

I notice that it is perhaps the weakest pupils who have benefitted the most from the interactive whiteboard. They are very eager, they dare to do more. It's like they aren't so afraid of making mistakes. They want to go up and have a try.

It's easier to adapt the education because I can start from scratch. The weaker pupils are given a chance and feel a sense of mastery. So I can move forward a bit, and in that way it's easier to make room for more.

Some of these points are also echoed in the pupils' statements concerning motivation and the use of IWBs.

Pupils' motivation for and experience of using IWBs

Interactive whiteboards ere used in nearly every lesson in the two classes we observed, something the pupils apparently enjoyed very much:

Interviewer: What do you think of using the Smart Board in almost every lesson? Is that okay?
The pupils [in unison]: Yes!

As judged from their replies, one of the main reasons the pupils were positive to the interactive whiteboard was that it improved their learning. 84 % of the pupils in the survey replied that the Smart Board improved their learning, while 14 % were unsure and answered "don't know". Active pupil participation was something that the pupils themselves highlighted as particularly positive, and several pupils claimed that this had changed since the interactive whiteboards were introduced. Another point they mentioned was that the interactive whiteboard makes it easier to focus on what the teacher is saying, in that the whiteboard visually reinforces the teacher's talking points.

Interviewer: …and you think that is easier to understand. Is that what you said?
Pupil 2: Yes, you see the point teacher is trying to make, [she] doesn't have to say it only. But we see it too.

According to the pupils we interviewed, the teaching also became more effective, something they viewed positively. The pupils attributed the improved effectiveness to the teacher's advanced preparations and to no longer having to see the teacher write the talking points on the board. One pupil also emphasized the advantage of being able to promptly display something from the Internet.

The pupils enjoyed going up to the board, and they mentioned that rules are in place for how this should transpire. The main principle is that all the pupils should have the opportunity to go up to the board:

Pupil: "We all take turns, everyone gets their shot. I think that's a good thing."

According to the teachers, none of the pupils expressed discomfort at the notion of going up to the board. On the contrary, the teachers suggest that several otherwise hesitant pupils wanted to give it a try:

Teacher: But I think in a way that you involve more pupils than you do with the old chalkboard. I think perhaps also that those pupils that are a bit cautious, the somewhat invisible pupils, have in a way become more visible.

95 % of the pupils in the survey "liked" or "liked very much" to go up to the whiteboard and solve problems, while only 5 % thought it was merely "okay". As we observed in the classroom, many pupils would raise their hand in the air when it was a question of going up to the board. Even though there were many pupils and everyone had to wait their turn before going up, one pupil stated that they kept their concentration because it is easier to pay attention when there is some activity. Another pupil explained that they were accustomed to technology and that it was easier therefore to focus on an interactive whiteboard; the same pupil added that children spend much time on computers in daily life, something that makes it easier to understand how to use the Smart Board. 88 % of the pupils in the survey agreed that it was easier to pay attention in class when the Smart Board was used, while 77 % disagreed that the Smart Board led to more classroom unruliness – in other words, most pupils believed that interactive whiteboards led to less noise in the classroom and made it easier to pay attention.

According to out classroom observations, station teaching led to greater noise, but much of the noise was because pupils were discussing the problems together. It must be added, however, that their conversations did not always stick to the subject matter; we also observed episodes where the pupils were somewhat unfocused, without that being a major problem. Over 50 % of the pupils in the survey replied that station teaching was something they "liked very much", 30 % replied "liked", while 16 % thought it was merely "okay".

Pupils in our interview mentioned their weekly response button test on Fridays, something they found more enjoyable than previous test methods. They found pushing buttons to be motivational in itself – the immediate feedback in particular was highlighted as a positive. The pupils also understood that it is easier to get the answer correct when there are alternatives to choose from.

P1: You also get more things right, because it's like A, B, and C, and then you can just push the button.
P4: And we get to know the answers at once, whether it's wrong or right, at once.
P1: Yeah, instead of waiting two to three weeks for the teacher to correct it. [The others laugh a bit.]

That the Smart Board does not always run as it should was cited as a negative aspects by the pupils. They also considered it a drawback that it the board must be calibrated every now and then, though they added that this was something most of them master. Another negative aspect, according to the pupils, is that the board for various reasons is not always easy to write on.

In several areas the teachers and the pupils concurred in their statements. The pupils stated that it is fun to go up to the board and solve problems, while the teachers stated that pupils are eager to go up and that they are able to involve more of the pupils. 88 % of the pupils in the survey agreed that it is easier to pay attention in class when a Smart Board is used. The pupils also stated that an IWB makes it easier to understand because it allows them to see what the teacher is saying; this corresponds with what the teachers said during their interviews. We can therefore say that both pupils and teachers believe that the use of IWBs motivates pupils to be more active. According to Peder Haug (2011), activity is a prerequisite for learning and the most active pupils have the best foundation for learning. A lack of activity leads to inadequate teaching conditions, even when the teacher is supportive. Adapting the education must be done through ordinary education and special education, and IWBs seem to enable teachers to create a foundation that fulfils the requirement that each pupil has the right to good teaching in the classroom. Hattie (2009) likewise found that both teacher feedback and motivation are key factors for the pupils' learning.

Pupils on the use of IWBs

In the survey the pupils were asked how often the teacher used IWBs in math class. 16 % of the pupils replied "always", 63 % of the pupils replied "usually, and 16 % replied "once in a while". None of the pupils thought the teacher used IWBs too infrequently in math, and 93 % thought that the teacher used IWBs the right amount of time.

The pupils were also asked how often the teacher used IWBs in Norwegian class. 2 % of the pupils replied "always", 51 % replied "usually", and 40 % replied "once in a while". 67 % thought the teacher used IWBs the right amount of time in Norwegian class, while 26 % of the pupils stated that IWBs were used too infrequently.

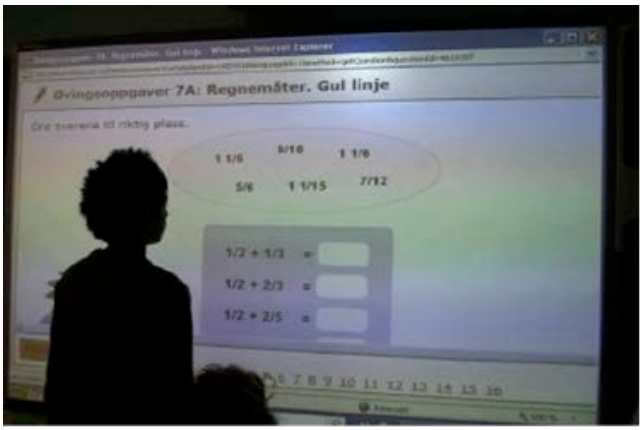
In the interviews the pupils were asked how often they used IWBs in class. The pupils answered that it was fairly often, with one pupil adding "usually in every lesson" ([00:02:07.11]).

Later in the interviews the pupils were also asked about how IWBs were used in class, and they were asked to describe a typical lesson. The pupils stated that they turned on the IWB and the computer to display relevant documents or presentations.

The math teacher designed her teaching in such a way that the pupils were able to answer the teacher's question and go up to the IWBs to show what they understood and how they had solved a problem.

A statement from pupil 4 ("We all take turns, everyone gets their shot. I think that's a good thing") suggests that the pupils were given the opportunity to use IWBs, and it seems that pupil 4 considered it to be a good thing that pupils are allowed to have a go at the board.

Observation forms were used in both Norwegian and math. It seems as though IWBs were used with equal frequency in both subjects. This was also addressed in the survey, with data there seeming to suggest that IWBs were used somewhat more frequently in math than in Norwegian. In the interviews, however, the pupils' opinions were divided: when the interviewer asked whether pupils "are up at the board as often in Norwegian as in math", one pupil replied that they do more in math, while another replied that math and Norwegian are the classes where they use IWBs the most.



Technical use of the whiteboard

A group of pupils were to collaborate on solving a drag-and-drop problem from the Abakus resource site, and they took turns performing the actions. It started with the pupil standing closest to the whiteboard stating that the answer to 1/2 + 1/3 must be 1/6. He attempted to drag 1/6 away from 1 1/6, something that was not possible because 1 1/6 was an image on the whiteboard and individual parts cannot be separated. His answer of 1/6 seemed to suggest that he was multiplying numerator with numerator and denominator with denominator.

The teacher then became aware of the discussion unfolding at the whiteboard and went over to help. Initially it seemed as though she was only concerned with how the pupils should use the whiteboard in a purely technical sense. She instructed, "You can press with only one finger, not two. Use your nail, that makes it easier." The pupil then replied, "The answer isn't there. It should be one-sixth. Three times two is six, and one times one is one." It did not seem as though

the teacher caught the pupil's reply; it was first when the pupil pointed out to the others that the answer was not there that teacher switched her focus from the purely technical aspects to the math problem itself, asking the pupils, "What do you have to multiply the numerator and the denominator with to get six?" After the teacher and the pupils discussed this question, the pupil dragged 5/6 from the answer box. The teacher rounded off the discussion by reminding the pupils that they are a group and that they must help one another.

Analysis: Technical use of the whiteboard and the teacher's object

When Mona discovered that a discussion was taking place in front of the whiteboard, her initial interest was only that the pupils should make the whiteboard work. It might therefore seem as though the teacher's object in the activity had changed (Engeström, 1999). She was now more preoccupied with getting the pupils to use the whiteboard correctly: "You can press with only one finger, not two." It also seems as though Mona overlooked Espen's arithmetic strategy – it was only after he repeatedly pointed out that his answer was not an alternative that she answered his actual question.

It is interesting to look at why Mona's object changed and why she became more preoccupied with technical matters than with being a math teacher. One possibility might be Mona's maturity in regard to the technology (Hooper & Rieber, 1995): if she herself was not entirely comfortable with the technology, it is conceivable that she would be more on the alert for pupils not using the whiteboard correctly.

When the teacher and the pupils subsequently started discussing how the problem was to be solved, Mona repositioned herself in her role as math teacher and posed questions that enabled the pupils to make progress.

The example shows that the software can be a mediating artefact for stimulating a discussion among pupils who are collaborating in front of the board. The technical aspects of the software and the whiteboard are a challenge here, however. The pupils spent much time scrolling up and down in order to obtain an overview of the problems, and the teacher's initial focus was on the technical aspects. The display design might thereby be a factor that hinders pupil activity and compels them to switch object from collaborating on the math problem to trouble-shooting the interactive whiteboard.

Technical competence and skills regarding the use of IWBs

We have chosen to differentiate between the technical challenges of IWBs and the educational use of IWBs. This is a two-step model where step 1 entails learning to master the technology and step 2 entails using the technology for subject learning.

When using interactive whiteboards in this project, the teachers and pupils encountered a variety of technical problems related to for instance boot-up, electricity/charging, Internet access, and calibration of the whiteboard and the driver installations. Such problems can usually be resolved quite easily, and during the project we saw a certain improvement in some areas. Technical difficulties are nevertheless not entirely avoidable, and the teacher must be attentive to such matters.

Whiteboard and software functions and usage also create intermittent problems, and examples of such difficulties in the project include:

- The Undo function in Notebook, where the button was given an uncommon placing and also disappeared when typing recommenced. A better Undo function would have mitigated many of the other problems.
- Writing turned out to be a challenge: the keyboard did not work particularly well, and it was often time-consuming and not always very functional. This is also because some resources were used that were at the outset not suitable for use with a keyboard. When writing with a pen tool, the whiteboard is exceptionally vulnerable if pressed elsewhere or if the board is poorly calibrated, and in the project there were several examples of text disappearing. It is worth noting that roughly half of the pupils in the survey thought the interactive whiteboards were difficult to write on, something that was also confirmed in the interviews.
- The teachers have had various problems with the Notebook functions, something that is probably due to maturity and competence, but improvements can also be made in the software. There were examples in the project of teachers struggling with hide-and-reveal and other specific functions.

Discussion

Classroom management, communication, evaluation, and educational design

Good classroom management is a matter of relating to the pupil, and it is there that we find the element of dialogue in the communication pattern of this sociocultural environment. This is then again a matter of planning and of the teachers recognizing the importance of establishing relations in the educational process. The teacher as class leader should have dialogue at the forefront when planning and shaping his or her educational design. The empirical data also show that pupils become involved and clearly motivated when the teacher recognizes the pupils' level

of learning. According to John Hattie (2009), "When pupils can move from idea to ideas and then relate and elaborate on them, we have learning – and when they can regulate or monitor this journey, then they are teachers of their own learning." Some of the episodes from our own data reveal a similar pattern with regard to the IWBs, but as yet to a less degree than what was the project's goal. We have brought to light a few good examples from the empirical data where the teacher as class leader facilitated good relations with the pupils through what we called the interactive and dialogic area (Scott & Mortimer, 2005). We saw the class leader who had planned for and facilitated this type of teaching in her educational design. In particular when communicating with the pupils, open-ended questions were used. What is as yet somewhat lacking is using the combination of both language and IWBs as mediating artefacts, so that both are incorporated in the interactive and dialogic area. However, we do see an emerging trend here, though it will take discipline and awareness among the teachers to implement a classroom culture that results in IWBs becoming a teaching tool for the entire class and not only the teachers. This requires a continued development of the educational design, so that the interactive and dialogic become the teacher's daily work method. The teacher interviews also confirm that IWBs remain as yet more a tool for the teachers than for the entire class. An experienced teacher described what could potentially happen if she were to think of something that was not included in her planning of the lesson:

> *"There might be something that I did not think about while planning and that I become aware of during the lesson. All I have to do then is open a blank page in Notebook and work on it. Or have two pages open, so that they can see the rules we made while at the same time working on a problem in for example math. I feel there is much more wiggle room, that's become my thing. I'm the one who controls the tool."*

That the teacher controls the tool is something we observed in much of the teaching.

Another characteristic of the teaching is that the teachers as class leaders recognize that the use of IWBs in education should promote pupil reflection, interim evaluation, and self-evaluation. In several of the lessons we observed that the teacher would start by presenting the lesson's achievement criteria, stating that those were the goals the class was to work towards during the lesson. As mentioned above, there is a clear recognition that this is a fruitful approach. The teachers also has an overview of the pupils in this method, this opens for an interim evaluation. The evaluation is sustained through the dialogue, so that the teacher's open-ended questions and the answers from each pupil create a solid foundation for further dialogue and for adapting the problems to each individual pupil. In contrast, the achievement criteria were often forgotten, by both the teacher and the pupils, so that there was no reflection for the interim evaluation or the pupils' self-evaluation. Instead, questions were often posed to the entire class, and hence the achievement criteria did not stimulate the pupil's learning process as intended. One type of question then became what one of the teachers said following a good dialogue on their work with

circles: "*So, what we've learnt then is that there is an equal distance from the centre to the circumference. We know that the distance from the centre to the circumference is the radius. The diameter is twice as long as the radius*.". The teacher has had a good session and dialogue with the pupils, but then summarizes and reflects on their behalf. As mentioned above in the section on the empirical data, the teacher's focus was on understanding rather than on hastily proceeding to the next topic, but when summing up the lesson the teacher forgot her good intentions and summarized on behalf of the pupils. She could have used a few extra minutes here, and at the same time achieved the necessary interim evaluation through for example the pupils themselves summing up the lesson and demonstrating their understanding.

Whiteboard teaching and motivation

The pupils stated that they enjoyed activities that made use of the interactive board. Both the survey and the pupil interviews indicated that the pupils are positive to the use of interactive whiteboards in class. This corresponds well with other studies and assessments (Hall & Higgens, 2005; Slay et al., 2007; Higgens, 2008; Somekh et al., 2009). Many of these studies are based on the pupils' self-reporting through interviews and focus groups. Our assumptions concerning pupil motivation are also based on self-reporting from pupil interviews and the survey, put in connection with classroom observations and teacher interviews. The overall picture that thus emerges is that interactive whiteboards help motivate pupils.

Torff and Tirotta (2009) conducted a study where one group of pupils used interactive whiteboards in class while a second group did not. A questionnaire was used to gauge the attitudes of both the teachers and the pupils. The result showed that the teachers' attitude to technology had the greatest influence on pupil motivation, and that this cannot be linked to the interactive whiteboard in itself.

The pupils in our study considered the use of interactive whiteboards to be motivational for their learning, as clearly shown by the results from the pupil survey. We must also see such motivation in context and both the pupil's and the teacher's attitudes to the technology will contribute to motivation (see Knezek & Christensen, 2008; Torff &Tirotta, 2009). The reason stated by the pupils for why they like the Smart Board is that it leads to activity.

According to the teachers, using the interactive whiteboard leads to more pupils being active during lessons and to more pupils solving problems in front of the class. The pupils had a clear notion that going up to the whiteboard was based on a communal system of taking turns.

The evidence suggests that pupils are less intimidated of going up to the interactive whiteboard to solve problems. The teachers stated that many of the less self-confident pupils express a desire to go up to the board, something that creates an equal opportunity for more pupils. In our classes

the interactive whiteboards were often used for station teaching, and pupils with differing skill levels collaborated on the problems.

During the lessons the interactive whiteboard was often used to introduce a new topic. We observed several times that pupils were asked to copy down information from the board, often key sentences for the topic under consideration or rules for the rulebook. What separates this from previous practice is that the teacher has written this in advance, and that the writing is printed rather than hand-written and should hence be easy to read. We nevertheless observed that pupils spent a good deal of time copying down the information.

Summary and conclusion

Our assumptions in regard to the teacher's role, educational design, evaluation, and communication were ambitious on behalf of the researchers, teachers, and school leaders who participated in the Nordic Smart Board Project. After a year of observing two classes and three teachers who taught Norwegian and math, we are left with many experiences and much we would like to continue with. The project has furnished us with a large collection of empirical data, including 40 hours of observation and video recordings, two rounds of teacher interviews, a pupil interview, and two pupil surveys; in addition, researchers in Sweden and Denmark collected a large amount of data through classroom observation (we were unable to access this data in connection with the Norwegian research report). Our project design included four key areas of focus, with added value coming from pupil interviews and the survey, wherein the pupils expressed their experiences with using IWBs in education. The four areas of focus were as follows: the teacher as class leader; educational design; communication and evaluation; and our assumptions in advance of the project. These assumptions were that

- the teacher's role is transformed by the teacher increasing classroom interactivity and pupil involvement through pupil activities and new forms of communication;
- IWBs help clarify educational goals and contents and facilitate learning (the pupils can link new information with what they knew beforehand), and that the teacher makes educational changes when planning and carrying out lessons with IWBs;
- IWBs strengthen pupil–teacher communication as there is less teaching and more dialogue (less monologue) between the teacher and his or her pupils;
- IWBs and an emphasis on interim evaluations enable a greater degree of differentiation and adapted education for both strong and weak pupils, which in turn stimulates the pupils to reflect on their own learning. (Project design for "Bored or Board", 2010)

Concerning the first assumption that the teacher's role is transformed, our conclusion is that this transformation occurs over time. The teacher as class leader is heading towards a teaching scenario with increased pupil activity and interactivity. At the same time we see that the class leader role might quickly revert to the traditional mode of teaching, unless the teacher is

conscious of his or her role. For a teacher to change his or her teaching and educational design requires deliberate planning. The teachers themselves also state in an interview that this is important. They also state that the very presence of researchers was one of the factors that motivated their attempts to change the teaching culture. This leads us to conclude that collaboration and mentoring might be necessary to avert the loss of interactivity in the sociocultural space. Achieving interactive and dialogic teaching requires that teachers be set to create a new educational design with a joint responsibility for observation and mentoring. This will take additional man-hours, but if the teachers use elements from teaching studies/Lesson Study in the work and use video to observe their own and one another's lessons, there is a high probability of achieving interactive and dynamic teaching with both language and IWBs as mediating tools. The path towards development was supported by the teachers during their interviews, when asked whether their dialogue and communication with the pupils had changed in any way. One of the teachers replied that this was perhaps due to the observation and the questions they were asked regarding the use open-ended or closed questions, before adding that "perhaps it is because of you that I have become aware of how I speak". Such work methods are supported by several research projects, including Hattie (2009), Murcia & Sheffield (2010), and Brown and Kennedy (2011), who write:

> *As the project progressed, teachers commented that they were seeing and talking about their classes in new ways. They reported a greater feeling of autonomy within their own professional development in having developed awareness, skills and confidence in ways of talking together that promoted reflection, support and challenge in working towards improving their practice.*

Interactive and dialogic teaching also increases the opportunities for interim evaluation, mutual evaluation and self-evaluation, because the communication will provide the pupils with a stronger basis for reflection. This means that open-ended questions in the classroom provide openings for more answers. We will thereby also enable a more adapted education, because the class can together make statements that might ultimately lead to common solutions in an area of concern. This was not carried out during the project, however: the teachers' initial presentations of the achievement criteria were by and large not followed up in class, but the tentative attempts show that there is a potential there.

The teachers' maturity in regard to an alternative teaching form, with increased use of open-ended questions and interactivity in regard to IWBs, has increased, but there is room for improvement in certain areas. We came a bit on the way to achieve our ambition of concluding the project with a good educational design, but to complete this would perhaps require an additional year-long collaboration. We will tentatively state that the teachers are on their way and that future work requires the teachers to be conscious while working to achieve the project design's goal. Norwegian teachers work in a school system with good financial conditions, but where there is a desire for an increased teacher–pupil ratio. The teachers themselves decide how

their lessons are to be prepared and which methods are to be used. The school system is further characterized by close proximity between teacher and pupil. These are conditions that are significant when the teacher introduces new technology, both because there is good access to equipment and training, but also because the teachers have the opportunity to experiment and to develop their practice. On the other hand the teachers' autonomous position entails the danger that new tools and opportunities are ignored. The teachers in the project were in this respect being honest when they pointed out that the external environments had an effect on their willingness to change and develop, thereby implying that such change would not necessarily have taken place otherwise. In a final conclusion for the entire project we concur with Murcia and Sheffield (2010) and conclude that at IWBs in education are only as effective as the surrounding pedagogy. We would also add that if the school management facilitates teacher collaboration, observation, and mentorship while working on a new educational design for the use of IWBs, the technology can become something more than an expensive board or screen for displaying PowerPoint presentations. Development and educational design might lead teachers to not merely transfer current blackboard teaching over to IWBs, but to explore new and interactive methods for changing and improving their teaching practice.

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