

# Interactive Whiteboards and Learning: A Review of Classroom Case Studies and Research Literature

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# Summary

This summary of educational case-study findings and research was compiled by SMART Technologies Inc. to help educators weigh the benefits of using interactive whiteboards in the classroom.

This paper brings together research and case study observations from the United States, the United Kingdom and Australia. It includes findings from the longest-running interactive whiteboard educational research programs, SMARTer Kids™ Research (<http://www.smarterkids.org/research>), sponsored by the SMARTer Kids Foundation of Canada. Of the available case studies and research compiled for this literature review, eighteen out of the thirty sources conducted research on the SMART Board™ interactive whiteboard.

Interactive whiteboards affect learning in several ways. They serve to raise the level of student engagement in a classroom, motivate students and promote enthusiasm for learning. In at least one case, the addition of an interactive whiteboard positively affected student attendance. Interactive whiteboards support many different learning styles and have been successfully employed in hearing and visually impaired learning environments. Research also indicates higher levels of student retention, and notes taken on an interactive whiteboard can play a key role in the student review process. In addition to a positive impact on student learning, observations also indicate that designing lessons around interactive whiteboards can help educators streamline their preparation and be more efficient in their ICT (Information and Communication Technology) integration.

# The Interactive Whiteboard in Education: An Introduction

## What is an interactive whiteboard?

An interactive whiteboard is a touch-sensitive screen that works in conjunction with a computer and a projector. The first interactive whiteboard was manufactured by SMART Technologies Inc. in 1991.

Educators were the first people to recognize the interactive whiteboard's potential as a tool for learning, meeting and presenting, and they continue to comprise the largest user base for this technology, particularly in the United States and the United Kingdom.

## How can an interactive whiteboard be used in a learning environment?

Interactive whiteboards are an effective way to interact with digital content and multimedia in a multi-person learning environment. Learning activities with an interactive whiteboard may include the following:

- Manipulating text and images
- Taking notes in digital ink
- Saving notes for review via e-mail, the Web or print
- Viewing websites as a group
- Demonstrating or using software at the front of a room without being locked behind a computer
- Creating digital lesson activities with templates and images
- Showing and writing notes over educational video clips
- Using presentation tools built into the interactive whiteboard software to enhance learning materials
- Showcasing student presentations

# Research Observations

## Connecting to Learn: Student Engagement

Learning has typically been a social activity for the simple reason that most human beings need to reinforce their beliefs and understandings by asking questions of others. Current learning theories promote student engagement and consider it to be a key component of knowledge construction. These learning theories include the following:

- **CONSTRUCTIVISM** – relies on the learner to select and transform information, construct hypotheses to make decisions and synthesize learning through personalizing knowledge
- **ACTIVE LEARNING** – learners actively engage in the learning process through reading, writing, discussion, analysis, synthesis and evaluation, rather than passively absorbing instruction (e.g., lecture model of instruction)
- **WHOLE-CLASS TEACHING** – brings the entire class together, focuses their attention and provides structured, teacher-focused group interaction

Perhaps one of the biggest challenges of computer-integrated learning has been maintaining dynamic interaction with students while they sit in front of computer screens. Interactive whiteboards help overcome this challenge and enrich ICTs by providing a large workspace for hands-on work with multimedia resources. Having a space large enough for everyone to see opens a channel to higher student interaction in both teacher-directed and group-based exchanges – one can interact with the tool at the front of the class and everyone can feel involved because of the interactive whiteboard's size. The interactive nature of the product and its accompanying software allow for the development of classroom activities that are engaging for students.

## Observations from the United States

"Does the use of an interactive whiteboard as an instructional tool affect student engagement? The unequivocal answer, based on the results of both the surveys and questionnaires, is yes.... The results of the survey indicate that interactive whiteboards can be used in the classroom to increase student engagement during the learning process" (Beeland 2002).

“The SMART Board [interactive whiteboard] was novel and created enthusiasm for learning on the part of the students as evidenced in remarks made during the lessons presented using the SMART Board [interactive whiteboard] and during individual student interviews, such as ‘I like touching the SMART Board [interactive whiteboard],’ ‘My finger is magic,’ ‘I like when the lines get different,’ ‘It’s a lot more easy [using the SMART Board interactive whiteboard], but I don’t know why,’ ‘We used the SMART Board [interactive whiteboard] and it went ding, ding, ding,’ ‘Every part of the word is special,’ and ‘The board is magic.’ Students were engaged when they actually touched the SMART Board [interactive whiteboard] or manipulated text on it” (Solvie 2001).

“The SMART Board interactive whiteboard supports interaction and conversation in the classroom; it helps with the presentation of new cultural and linguistic elements” (Gerard 1999).

“It engaged my primary students in literacy learning.... I was able to interact with the class, demonstrating, modeling and manipulating what was on the board by touch. I was not confined to, or focused on, a computer that separated me from the class.... Visual display in the form of diagrams, webs and pictures, as well as use of colors and shapes to highlight text, prompted engagement” (Solvie 2004).

### **Observations from the United Kingdom**

“The students’ initial response to use of the whiteboard during classes was enthusiastic, as the visual impact of the tutor simply touching the screen to start applications is initially quite dramatic. The immediate advantage of this arrangement compared to seating students at individual workstations has been that websites can be examined as a group activity, so that communication between members of the group continues, whether in English or in a foreign language (some students have remarked in the past that while individual computer work is useful, it can limit communication in the foreign language between group members). A further benefit is derived from the fact that several members of the group are not especially computer literate and are daunted by the prospect of seeking out and using websites on their own, particularly interactive sites which require regular responses from them. Being introduced to sites in a group situation, where the tutor can point to the screen and touch the relevant buttons without having to move away to the side to use a mouse or keyboard, is a useful tool in showing them how to achieve this step by

step. It allows members of the group to ask and hear others’ questions and reactions before starting tasks individually” (Reed 2001).

“One shared image in the classroom encourages discussion.... The pace of the lesson is increased.... It encourages teachers to plan lessons which involve interactive whole-class activities. The teacher can look at the class, rather than at the computer keyboard (which would be the case if a computer and large monitor or image projected onto a wall were used).... The teacher can concentrate on pupils’ responses” (Ball 2003).

“It quickens the pace of lessons and engages the whole class more. It is much more immediate” (Cunningham, Kerr, McEune, Smith and Harris 2003).

“[The teacher] would always choose the whiteboard for its flexibility and the opportunities it allows for individual and whole class assessment as the teacher works with the class” (Edwards, Hartnell and Martin 2002).

“Two thirds of the teachers felt that the whiteboard offered strategies for teachers to develop interactive teaching. One third stated that pupils from all ability groups were now more willing to take part in lessons. Observations of lessons confirmed the teachers’ perceptions. All of the lessons were seen to use a high level of whole class interactive teaching” (Latham 2002).

“The use of an interactive whiteboard enables teachers to gather extensive feedback from pupils by listening to their explanations. From this, teachers are able to gain deeper understanding and progress. Pupils collaborating in pairs or teams using subject-specific ICT resources are able to challenge each other’s understanding and learn from such collaborations” (Cox, Webb, Abbott, Blakeley, Beauchamp and Rhodes 2003).

### **Observations from Australia**

“The class is the focus of teaching activities involving ICTs, instead of individuals or a small group. [ICTs provide for a] more interactive, less didactic approach where the class can interact with the content and context of the lessons digitally through the ability to capture, combine and manipulate information from a variety of sources. The digital convergence of information from a variety of sources and devices is managed in real time by the teacher [when using ICTs]” (Kent 2003).

“All the children, parents and teachers interviewed [on the use of interactive whiteboards in education] believed the teaching was more fun, more engaging, more exciting and was impacting upon the enjoyment, speed and depth of learning” (Lee and Boyle 2003).

## **Get Focused: Motivation and Attendance**

Motivation is best described as a student’s drive to participate in the learning process. Although students may be equally motivated to perform a task, the sources of their motivation may differ. Some students are intrinsically motivated to learn because they are driven to understand through self-reflection and participation in learning activities, benefiting self-esteem. Others require extrinsic motivation such as enticements, rewards or educator-defined goals.

Interactive whiteboards appeal to both types of students:

- Intrinsically motivated students volunteer to demonstrate knowledge on the interactive whiteboard in front of their peers as a means of showcasing individual achievement
- Extrinsically motivated students are enticed by the wow factor of the technology and can become motivated learners as a result of the enjoyment they experience from using the product

Greater classroom enjoyment and motivation – particularly on the part of extrinsically motivated learners – can in turn lead to fewer student absences. Interactive whiteboards are captivating enough to successfully compete with a student’s favorite consumer technologies (e.g., game devices, cell phones and MP3 players), focusing students on task, garnering enthusiasm and providing additional motivation to attend class. More than a diverting gadget or game, interactive whiteboards successfully promote the computer skills students require for success in the twenty-first century.

### **Observations from the United States**

“Students like to work on the SMART Board interactive whiteboard! They love to use a board that can be operated simply by touch. They may even ask to be quizzed, simply for the fun of writing on the board. It brings true excitement to the classroom” (Gerard 1999).

“Answers to open-ended questions indicated that students were more involved, attentive, and motivated when lessons were offered using the board rather than using other teaching methods” (Bell 1998).

“[R]esearch shows that if students have the opportunity to view someone they like or respect perform a behavior they need acquire, then they stand a much better chance of acquiring that behavior.... [T]he SMART Board [interactive whiteboard] allowed the students to watch peer leaders prompt and perform the appropriate behaviors, which made the ownership of those behaviors much more enticing.... [R]esearch also has shown that people with short attention spans can attend to any situation as long as it is on a television or computer screen. The SMART Board [interactive whiteboard] provided these students with this type of viewing. Finally, SMART Board [interactive whiteboard] technology was new to these students. This novelty made their training more interesting” (Blanton and Helms-Breazeale 2000).

“[U]se of an interactive whiteboard can make learning more enjoyable, interesting, and students pay better attention” (Johnson 2004).

“[Interactive whiteboards] can enhance any lesson and entice students to learn. With the use of whiteboards, teachers can develop many creative ways to capture students’ attention and imagination” (Reardon 2002).

“[S]tudents in the technology-enhanced sections reported more enthusiasm and interest in the course than did the students in traditional sections, and, perhaps as a result, the retention (student attendance) rate in the experimental sections was much higher than in the control sections.... [T]he retention rate – 97.1 per cent – was markedly higher in the interactive whiteboard-enhanced sections” (Tate 2002).

### **Observations from the United Kingdom**

“In particular, teachers reported the use of the interactive whiteboard for whole-class teaching to increase pupils’ attention and reduce much of the usual fidgeting during ‘carpet sessions’. These findings were further supported by lesson observations.... The evidence suggests that the boards made teaching more visual and learning more interactive, in turn encouraging greater participation from the pupils, improving their motivation and concentration” (Bush, Priest, Coe et al. 2004).

“They support self-esteem [and] empower children by dint of its sheer size for creating, viewing and manipulating pictures, sound and text.... [A] child can take on teacher rather than pupil role – equalises relationships.... The children are absorbed and empowered, with numerous opportunities for interactivity of different kinds.... Implicit in here are the positive emotions of success and pride in being able to operate the large screen and the status it has in the eyes of adults.... [Interactive whiteboards] engage children and focus their attention in a multi-sensory and varied way allowing them to be absorbed and emotionally involved in the learning process. This could be seen in observations and teachers articulate this in interviews” (Cooper 2003).

“The visual nature of interactive whiteboards was seen as a particularly valuable way to focus students’ attention and keep them on task.... Using [the laptop] with the interactive whiteboard, the kids were amazed. It’s visual which is good, especially with fidgety children, and it grabs their attention. It means there is more attention from everyone in the class and it’s big so everyone can see” (Cunningham, Kerr, McEune, Smith and Harris 2003).

“Pupils have been lining up to answer questions [and are] eager to try.... I feel I am providing a more informative and interesting curriculum” (Greenwell 2002).

“In their questionnaire responses, 66 per cent of the teachers noted a significant improvement in pupils’ attitude and response to mathematics lessons, while 16 per cent stated that pupil response was high prior to the introduction of the project” (Latham 2002).

“Using the software displayed on the large electronic interactive whiteboard was a very useful teaching tool. It enabled me to immediately focus all the children’s attention at the outset of the lesson. Children are always enthusiastic and show heightened motivation when [an interactive whiteboard] is used in the classroom and, in my experience, it creates greater attention and enthusiasm to participate and respond” (Richardson 2002).

“The special-needs teacher noted that the most significant attribute was the attention and motivation the students had when working with the board.... The sustained motivation and persistence with the use of the board are the two key factors in aiding with learning outcomes” (Salintri, Smith and Clovis 2002).

“[Seventy-eight] per cent thought the students were very motivated by the whiteboard. In one lesson, the students were very excited and really got involved with enthusiasm, they all wanted to touch the board. Students thought it was cool.... Students could take an active part in class teaching by coming up and demonstrating to the whole class and gained confidence in their skills by doing so.... Students were very motivated by the whiteboard lessons and commented on the fact that they had been able to understand much better what to do by being shown rather than being told. Students remembered the lessons and hopefully this will provide a prompt to the learning aim of the lesson.... The interactive nature of the whiteboard caused the most excitement for both staff and students. Students were very enthusiastic and wanted to have a hands-on role” (Smith 2000).

“One teacher reported that pupils who hardly ever spoke in class were motivated to discuss work with their peers, and that he was able to learn much more about what such pupils really understand.... Interactive whiteboards [can] promote class discussions, and [improve] pupils’ explanations and presentation skills” (Cox, Webb, Abbott, Blakeley, Beauchamp and Rhodes 2003).

### **Observations from Australia**

“When one can sit and listen to five-year-old children in kindergarten express what is distinct about whiteboard-focused learning at Richardson and how it assists them to learn more, faster and in a more enjoyable and interesting way, then one senses something rather special is happening” (Lee and Boyle 2003).

# Reaching Out: Learning Styles and Special Needs

Every day, educators strive to develop strategies and tools that will reach students with unique or diverse learning needs. Many of these learning styles – even the requirements of visual, hearing-impaired and other special-needs students – can be addressed when lesson delivery and learning activities incorporate use of an interactive whiteboard:

- VISUAL LEARNERS benefit from note taking, diagramming and manipulating objects or symbols. As the interactive whiteboard is easy to use, it enables students of all ages to see their own writing and objects of their own creation when they use the product.
- KINESTHETIC OR TACTILE LEARNERS, typically difficult to engage in traditional classroom activities that are usually more visual or auditory in nature, are able to reinforce learning through exercises involving touch, movement and space on an interactive whiteboard
- DEAF AND HEARING-IMPAIRED LEARNERS rely primarily on visual learning, and the interactive whiteboard facilitates both the presentation of visual material and the use of sign language simultaneously in front of students
- VISUALLY IMPAIRED STUDENTS with some vision ability can manipulate objects and use text on an interactive whiteboard's large surface and participate in computer-based learning in ways that would not be possible on a smaller computer screen
- OTHER SPECIAL NEEDS STUDENTS with individual learning requirements ranging from physical ability needs to behavioral issues such as Attention Deficit Disorder (ADD) also find the large interactive surface valuable. Its large size and touch sensitivity facilitates ICT learning beyond the standard keyboard and mouse type of computer interaction, and its appeal can be used to promote good behavior.

## Observations from the United States

"The addition of sharp color helps with multisensory learning. One of the grade three students had trouble with short-term memory and the application of color codes to words and phonetics has shown some encouraging results. The student repeats the task by coloring the printout to match the board work.... The special-needs teacher enjoys working with the students and the SMART Board [interactive whiteboard] because of the reduced anxiety, the improvement in the concentration of the students and the flexibility and ease of its tactile use" (Salintri, Smith and Clovis 2002).

"Every student wanted to give a response to write on the board. Students who sat lifeless before were on the ends of their seats, hands ferociously waving in the air, yelling, 'Pick me, Mrs. Jamerson, pick me!' ... Prior to technology integration, it took about four or five warnings [to moderate the behavior of the two ADHD students in the class]. But now, I warned that if [one student] made any more outbursts he would ruin his chance to write on the SMART Board [interactive whiteboard] later. This was enough incentive to keep his impulsive and hyperactive behavior under control. The students with ADHD were very attentive, and less impulsive and hyperactive during technology-integrated instruction" (Jamerson 2002).

"The [interactive white]board engaged students through kinesthetics as they used markers or their hands to respond to the text, highlighting with color or drawing boxes and circles with the tips of their fingers or the palms of their hands. The first graders loved writing with the markers and their fingers on the board. Fingers could be used when someone held the marker, leading the board to recognize and create the line width and color of the missing marker. Writing with fingers allowed the children to feel the shapes of words they outlined, feel and see letter components that created sounds they uttered, and experience a true hands-on approach to creating and erasing text. The board allowed use of multiple senses, leading to increased levels of engagement and greater understanding" (Solvie 2004).

"[The teacher has] been able to play videos on her SMART Board interactive whiteboard and enlarge the text so her [vision-impaired] students can see details they can't usually see on a computer screen. They are finally able to see and interact with a computer image, which is very valuable" (Cooper and Clark 2003).

### Observations from the United Kingdom

“Visual learning through the use of a whiteboard can range from the use of text and pictures to the use of animation or video. Activities that involve auditory learning include the use of words orally for pronunciation, speeches and poems. Allowing students to physically interact with the board can assist with meeting the needs of tactile learners. Numerous software programs can be used that involve user contact with the whiteboard” (Beeland 2002).

“This case study aims to provide evidence that using an interactive whiteboard with primary-aged pupils is an effective tool and, more specifically, that it is of particular benefit to deaf, bilingual children.... At Longwill, we try hard to develop children’s self esteem and pride in their abilities. The project did much to promote these aims. The pupils used the interactive whiteboard to make a presentation to friends and staff. ICT holds a high degree of status for children and clearly has a motivating influence on them.... Opportunities to develop interactive activities were endless. Having a projector and whiteboard in class provide[s] many positives, but the interactivity of a SMART Board [interactive whiteboard] enhanced teaching and learning even further” (Carter 2002).

“Being able to present students with visual stimuli by projecting from a laptop onto a whiteboard was seen to be of particular benefit by some special-school teachers. A teacher said, ‘With our kids, what you want is visuals. You need something to grab their attention.’”(Cunningham, Kerr, McEune, Smith and Harris 2003).

“[Another teacher observed that] improvement in class focus is due to the very visual nature of teaching with the whiteboard. [It] has really motivated the children, and methods can be modeled much more clearly” (Latham 2002).

“The nature of the interactivity and the images that can be used to reinforce learning is vital in teaching SLDD [specific learning difficulties and/or disabilities] students. To participate in the learning process (and have all the facilities of the word processor to create professional-looking end products) helps students to engage in a way that would not normally be possible in a classroom situation, adding to the richness of the learning experience” (Pugh 2001).

### Observation from Australia

“Of particular importance to the younger children was the tactile nature of the medium, that ready ability to engage

with the material on the board and for the children to use their finger nail to open files, to write or simply to highlight a point” (Lee and Boyle 2003).

## Making the Grade: Review and Retention

There are many variables that factor into student retention of information. The majority of available research on student performance focuses on qualitative observations regarding strategies for information retention; some studies of interactive whiteboard use in education are statistical in nature, but many more provide qualitative impressions.

A student’s ability to retain and recall information presented in class is subject to several conditions. Several of these conditions relate to student engagement and motivation during the class itself – the details of which are described above. A student’s success is also greatly aided by the availability of accurate notes after class for review.

Learning with interactive whiteboards in the classroom enables effective student retention and review in the following ways:

- Lessons are more memorable because students are more engaged and motivated. Students are able to focus more on the learning moment rather than on worrying about capturing everything through note taking
- Several different learning styles are accommodated when learning is delivered with an interactive whiteboard, improving chances of student retention during class
- Notes generated on an interactive whiteboard can be printed or e-mailed for distribution after class, ensuring the student has good review material to support information retention

### Observations from the United States

“The SMART Board interactive whiteboard used as a tool, in combination with effective teaching strategy, [brings] about dramatic results. The level of enthusiasm in Ms. Moore’s math class is far above that of a typical first grade classroom. Not only did the level of interest among students heighten;

Ms. Moore was challenged to think and teach in a new way. This teacher shared the enthusiasm of her students and thought of various ways to promote interaction, stimulate discussion, and make learning easy and enjoyable in the process" (Clemens, Moore and Nelson 2001).

"[T]he groups using the SMART Board interactive whiteboard produced analyses: (1) with greater semantic congruency between the diagrammer's and their other members' diagrams, (2) with a greater comparable number of elements to the analysis and (3) with less structural congruency between the diagrammer's and other members' diagrams.... The quality of the results seem to indicate that the layers provided by the SMART Board interactive whiteboard allowed members of the experimental groups to reach greater semantic similarity" (Vitolo 2003).

"The SMART Board interactive whiteboard produced positive grade changes from six-week to six-week period as well as from unit to unit. Use of the SMART Board interactive whiteboard appears to be a positive tool for assisting functional math achievement with struggling learners" (Zirkle 2003).

"One basic feature of the SMART Board interactive whiteboard is that there are many possibilities for overwriting any projected object. This allows the student to focus. They are not so easily lost and they know what the teacher wants them to select. Because the teacher can emphasize any particular structure by highlighting, underlining, or circling with different colors, it is easier for students to organize new concepts. The SMART Board interactive whiteboard is a valuable learning tool" (Gerard 1999).

"While it is difficult to prove if [interactive whiteboards] boost student grades, they definitely improve students' attitude toward learning and ability to understand complex concepts.... [I appreciate the ability to] record class notes and homework assignments [and] prerecord a daily lesson [for students] when they will be absent from school. Although the teacher isn't seen, students still hear the teacher's voice and see what was written on the whiteboard" (Reardon 2002).

"It proved to be an organizational tool for lesson preparation and an effective way to follow up on instruction.... Everything was saved to the computer, work could be revisited, revised, printed and shared – either electronically or via hard copies – immediately and within the context of the lesson" (Solvie 2004).

## Observations from the United Kingdom

"Evidence gathered through this evaluation demonstrates that interactive whiteboards offer significant potential to raise attainment through developed, well-structured interactive teaching and learning" (Latham 2002).

"Used alongside my established programs of study, I feel I am providing a more informative and interesting curriculum.... Their retention of the skills taught has been excellent" (Greenwell 2002).

"It's easier to understand.... The pace of the lessons is increased, because the teacher does not waste time thinking about the next question, writing it on the board, etc." (Ball 2003).

"Mark felt a major benefit of using the SMART Board [interactive whiteboard] and SMART Notebook™ [software] here was that, had a child arrived late to the lesson after the initial introduction, he'd still have a copy of what that child had missed" (Towlson 2003).

## Observation from Australia

"The large visual-stimulus facility was seen as particularly important, as was the ready ability to 'replay' work. The boards and a scanner allow the teacher to transform an A4 page into a very large image, to then manipulate that image and, if desired, to 'play back' work done. For example, with children's handwriting, the system can replay, in slow motion, the child's writing of a letter. This kind of facility not only engages the children, but also holds their attention" (Lee and Boyle 2003).

# Get Ready: Teacher Preparation

Efficient use of technology by educators is essential to successfully enhancing student learning. Once educators have received professional development and an educational technology installation is up and running, ICT integration should mesh seamlessly with the rest of the curriculum and help streamline lesson preparation.

Interactive whiteboards enhance teacher preparation:

- They are easy to use for both teachers and students, shortening start-up time for integrating interactive whiteboards into lessons (with additional features and tools to learn and use as skill levels grow)

- They motivate teachers to adapt lessons to incorporate and develop more digital resources. Teachers respond enthusiastically when they observe positive attitudes and behaviors from students using interactive whiteboards.
- Teachers can save notes for use next class or next year. Interactive whiteboards make it easier to build a collection of learning materials that can be constantly updated and written on top of, keeping lessons fresh and interactive.

### Observations from the United States

"Our pilot results showed that more female than male FSG [Faculty, Staff, Graduate students] attended SMART Board interactive whiteboard training sessions.... Female faculty seemed as eager and as capable as male faculty in SMART Board interactive whiteboard training and classroom use.... Based on the SMART Board interactive whiteboard's user-friendly features and advantages as perceived by most of the participants, this emerging technology can have a widening impact upon educational instruction" (McNeese 2003).

"It proved to be an organizational tool for lesson preparation and an effective way to follow up on instruction" (Solvie 2004).

"It promotes the organizational skills of the teacher" (Gerard 1999).

### Observations from the United Kingdom

"A number of teachers indicated that the interactive nature of the board was freeing them from the time-consuming task of making resources, such as number cards, again reducing their preparation time and reducing duplication.... There was clear evidence of teachers saving entire whiteboard lessons for future use. Nearly all teachers reported that in the long run, the ability to save and edit lessons would reduce preparation time and save unnecessary duplication" (Bush, Priest, Coe et al. 2004).

"Eighty-four per cent of the teachers felt that their planning and preparation was now more effective than before" (Latham 2002).

"The teacher also had positive attitudes to the big screen because it enabled her to do her job more effectively" (Cooper 2003).

"Teachers using an electronic whiteboard instead of a blackboard...had the additional advantage that they could save their notes for use later." (Cox, Webb, Abbott, Blakeley, Beauchamp and Rhodes 2003).

"It encourages teacher to plan lessons which involve interactive whole-class activities" (Ball 2003).

"The teacher also used SMART Notebook [software] to prepare written problems ahead of time for the children, enabling them to quickly and efficiently explore different solutions to given problems. They could also annotate and save these annotations quite simply as they occurred" (Worth Primary School 2003).

### Observations from Australia

"The interactive whiteboards have allowed teachers to take advantage of the power of ICT within the teaching component of the teaching and learning process in ways that are just not possible with the traditional personal computing approach to ICT in schools" (Kent 2003).

"All the teachers using the boards commented on their need to shorten their program timelines. The children would appear to be completing work faster and in greater depth [using interactive whiteboards]" (Lee and Boyle 2003).

## Conclusion

The interactive whiteboard has been incorporated into learning environments for over a decade, and an increasing flow of research into its impact is emerging from the United States, the United Kingdom and Australia. From the available body of research, several themes and patterns are evident, including the positive effect interactive whiteboards have on student engagement, motivation, the ability to encompass a variety of learning styles (including special-needs students) and the ability to enhance student retention and review processes. Observations also indicate that designing lessons around interactive whiteboards can help educators streamline their preparations and be more efficient in their ICT integration.

# Bibliography and Further Reading

Research reports, magazine articles and case studies highlighting engagement, motivation, learning styles, retention and review, and teacher preparation findings with regard to interactive whiteboard use appear alphabetically, by category, below.

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