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The interactive whiteboard in primary school science and interaction

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ABSTRACT

The findings of the research literature about the necessity and contribution of Interactive Whiteboards (IWB) are not unequivocal and are sometimes contradictory. The study aimed to examine the interactive attributes in lessons with an IWB and the students' attitudes. Methodical structured observations of 26 science lessons were conducted in elementary schools in Israel. The results showed that the teachers frequently used the diverse IWB tools, but most of the learning took place in frontal, whole class learning. Most of the interaction was under the teacher's control and the dialogic interaction was limited. The attitudes of 62 pupils showed that despite already studying with an IWB for five years, their enthusiasm did not wane. They even claimed, in contrast to the observation findings, that the IWB contributed to active learning and interaction in the class. The research findings raise fundamental questions regarding the place of the IWB in promoting interaction in the class and on the necessity to promote the teacher's pedagogic concept in order to increase class interaction.

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Introduction

The Interactive Whiteboard (IWB) is a large, touch-sensitive board, connected to a computer and to a projector which offers an attractive colorful picture, enables manipulating texts by deleting, coloring and saving them, including combining pictures, applications, programing, web pages and so on.

The use of the IWB increased in recent years in schools around the world, and its popularity has been enhanced amongst many teachers (Future Source Consulting, 2010; Murcia, 2014). The IWB penetrated schools in England most in comparison to other countries around the world. It was introduced mainly to elementary schools as broad support by the government in order to advance student literacy and numeracy. Mexico began to combine IWB in schools in 2004, shortly after England, and many other countries in its wake, wherein the trend in all the countries is of an increase in the introduction of IWBs to school. Nowadays the IWB can be found in approximately 90% of classrooms in England, and in Holland, Denmark and Australia it stands at 60%–70% of the classrooms. In the USA, Canada and Spain IWBs are found in about half the classrooms and in other countries such as Germany, Korea, China, Italy and Israel it stands at about 20%–30% of the classrooms (Hennessy & London, 2013).

Although computers were already introduced to schools more than 30 years ago, many teachers do not use them in their daily teaching. But each teacher needs a board and the IWB may be the missing link in the connection between teaching and learning and the digital world. In other words, for many teachers the IWB may be an inviting bridge to the more significant use of digital technologies in class (Betcher & Lee, 2009).

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It was claimed that IWB has powerful pedagogic potential and the financial investment in its introduction to classrooms is impressive (Digregorio & Sobel-Lojeski, 2010; Hennessy & London, 2013; Somyurek, Atasoy, & Ozdemir, 2009). Interaction in the classroom is a significant factor in its pedagogic potential as manifested in the board's name.

IWBs were entered to classrooms around the world more than ten years ago, but only few empirical studies explored directly the contribution of the IWB to teaching and learning. The studies on interaction are particularly few (Clarkson, 2011; Erbas, Ince, & Kaya, 2015; Smith, Higgins, Wall, & Miller, 2005). Moreover, the studies that explored the contribution of the IWB to classroom interaction afforded contradictory findings. Some of them showed that the IWB encourages interaction (BECTA, 2008; Blue & Tirotta, 2011; Slay, Siebörger, & Hodgkinson-Williams, 2008) in contrast to those that claim that interaction, combined with the IWB, is superficial and that the teachers use the IWB mainly for purposes of presentation and frontal, whole class teaching (Kearney & Schuck, 2008). Thus, the question regarding the contribution of the IWB to class interaction remained open to empirical study.

Project "smart classes" began about ten years ago in several schools in Israel as part of the process of adapting the education system to the twenty-first century. The project's main goal is to generate change in the school learning culture by assimilating advanced technologies. Specifically the objectives include, amongst other things, advancing inquiry and cooperative learning, and increasing the interaction in the learning process. The project was based on establishing technological infrastructures in school that included laptop computers for students, computer stations for teachers, IWBs, an audio system and a wireless internet connection. In addition, considerable resources were invested in instruction programs for school teachers.

Two teachers and their students from two elementary schools, that were included in the "smart classes" project, participated in this study which focused on examining the attributes of whole class interaction in an attempt to assess the impact of the IWB. Through structured observations in lessons we explored the types of interaction and their extent, and the learning organizations and their frequency. Moreover, the students' attitudes to learning with an IWB were examined.

The literature review

The IWB embodies possibilities for improving teaching and learning (Smith et al., 2005). The availability and the ease of manipulating learning materials through the IWB, such as including pictures, video, simultaneous presentation of various sources, coloring text, and so on, is powerful key that contributes to teaching and learning (Betcher & Lee, 2009). The IWB, characterized as a touch-sensitive board, alleviates the effectiveness of the presentation and enables more professional teaching with multimedia sources (Glover & Miller, 2001).

The IWB enables more rapid flow and pace of the lesson (Ball, 2003), and teachers report effective learning amongst their students (Betcher & Lee, 2009; Hennessy, Deaney, Ruthven, & Winterbottom, 2007; Miller, Glover, & Avris, 2004; Wall, Higgins, & Smith, 2005). When the connection between the use of IWB and the students' knowledge was explored directly, the findings were not unequivocal; sometimes the IWB did not lead to improving knowledge (Higgins, Beauchamp, & Miller, 2007; Lewis, 2003; Swan, Schenker, & Kratcoski, 2008), although it seemed that the IWB improved, for example, understanding of complex mathematical and scientific concepts (Hennessy et al., 2007; Mildenhall, Swan, Northcote, & Marshall, 2008).

Smith et al. (2005) warns that the advantages described should be taken cautiously. She argues whether, and to what extent, these advantages can be directly related to teaching with an IWB, if they cannot be achieved using cheaper computer technologies.

From the students' point of view, they thought that learning with an IWB is enjoyable, encourages motivation, increases concentration, and also interaction with the teacher and students (BECTA, 2008; Higgins et al., 2007; Morgan, 2008). The students' criticism focused on technical problems that

sometimes arise in teaching with an IWB, and they claimed that the teachers are not always sufficiently skilled in its use.

It was claimed that one of the prominent advantages of the IWB is its contribution to the pedagogic interaction in the class. In general, this can be classified as interaction between the teacher and the students, amongst the students themselves, and between the students and the technological tool (Blau, 2011). The IWB, that is mainly a tool for the teacher, enjoys the main thrust of the teacher's interaction with a whole class (Tanner, Jones, Kennewell, & Beauchamp, 2005). This study focused on the interaction between the teacher using an IWB in whole class, while exploring the dimension of involvement in, and control of, the lesson.

According to the social constructivist approach to interaction, a student constructs new knowledge in the social context of the classroom (Jones & Tanner, 2002). A certain degree of interaction must exist between the student and the teaching content, for learning to occur. But for this interaction to be meaningful, the learners need to be involved socially and contribute to the collective understanding (Tanner et al., 2005). Interaction is likely to promote intense cognitive processes amongst them, such as language development or inquiry ability, when students construct meaning through class discussions and conversations with other students and teachers (Mercer & Littleton, 2007; Moreno & Mayer, 2007; Wegerif, Mercer, & Dawes, 1999).

Previous studies offer a classification of classroom interaction that varies from ''authoritative'' to ''dialogic''. This is a range that can vary between the ''lecture'' approach, according to which the teacher controls the lesson content and its progress, through encouraging questions for discussion and raising different opinions amongst the students, through to teaching in which the students and the teacher have an equal contribution to developing lesson content and structure (Alexander, 2004; Beauchamp & Kennewell, 2010).

The research literature consistently recommends increasing the dialogic interaction, which is likely to improve the learning processes (Ford & Wango, 2012). A non-hierarchical approach exists in dialogic interaction based on tolerance, a type of shared learning, rather than instructional speech between teacher and pupil. The dialogue is not only functional or technical but characterized by exchanging ideas (Alexander, 2004; Mercer & Littleton, 2007). Dialogic interaction emphasizes the conceptual flexibility, that, in contrast to teachers' focused interaction that presents only their world-view, encourages a variety of approaches and ideas (Scott, Mortimer, & Aguiar, 2006).

In the lecture, there may be very little interaction between the student's learning process and the teaching (Tanner et al., 2005). However, according to Scott et al. (2006) the picture is more complex. In certain cases the teacher is likely to present diverse and varied approaches that characterize dialogic teaching without direct interaction with the students. Moreover, there are situations in which the teacher holds a conversation with the students but aims only at one opinion or specific idea. Such situations are termed by Mortimer and Scott (2003) as non-interactive/ dialogic and as authoritative/interactive respectively.

Another factor directly influencing the type of interaction at each stage in the lesson is the teaching objectives: for example, when the teachers raise a problem they are likely to be the main speakers, in contrast to situations in which they examine their students' views. According to Mortimer and Scott (2003), in interaction between the teachers and their students there is constant tension between the authoritative approach and the dialogic approach. Both approaches should mesh, wherein the transition between them at each continuum in the lesson is critical for meaningful learning.

Several studies report that the IWB contributes to encouraging interaction in class (BECTA, 2008; Blue & Tirotta, 2011; Slay et al., 2008). In contrast to these reports it was found that in practice, the use of the IWB in a lesson does not assure the encouragement of the interaction (Hennessy et al., 2007). Moreover, it was claimed that the IWB actually encourages frontal teaching, using the lecture approach that does not advance mutual and direct interaction with the students (Lewis, 2003; Somekh et al., 2005).

The level of pedagogic interaction that occurs in teaching with an IWB and its quality depend largely on the teacher's mastery of IWB technical skills and professional knowledge (Blau, 2011; Yang & Teng, 2014). The development of dialogic interaction is a complex process necessitating the teachers' in-depth understanding of the learning process (Tanner et al., 2005). Teachers prefer teaching following the method with which they are familiar. In order to change it they must believe in the objectives of the change, commit to them, and to develop the necessary skills. Change cannot be forced, for if so, it is liable to lead to superficial results (Fullan, 1993).

Teachers report, for example, that inviting students to write answers on the IWB to their questions increases interaction. However, if the teacher only assesses the correctness of the students' answers, such interaction dose not encourage thought or the development and presentation of the students' ideas. Moreover, it is not significantly different from the class interaction in lessons without an IWB (Smith et al., 2005; Smith, Hardman, & Higgins, 2006).

Betcher and Lee (2009) note three stages in the development of the use of the IWB. At the first stage the teachers impart the same content using traditional methods. At the second stage, the teachers introduce certain changes but without in-depth alteration in teaching methods, and only at the third stage is innovative pedagogy applied. According to another model presented by Burden (2002), at the first stage the IWB reinforces the existing, mainly passive, pedagogy with the students; at the second stage the existing pedagogy changes and there is an attempt to make the students active; and at the third stage the use of an IWB affords added value to the learning process with dialogic interaction between the teachers and the students. At the third stage the teachers use and create diverse learning resources and the students are involved in developing the knowledge. Although the two models use different concepts to describe the development of teaching using an IWB, both relate to stages that move on a sequence from a traditional frontal and authority teaching to higher interactive teaching.

This study tracked relatively experienced teachers integrating an IWB in their teaching and their schools who underwent a process of assimilating computer technologies prior to the introduction of the IWB. The preliminary assumption was that these teachers are at least at the second stage of integrating an IWB in their teaching. This hypothesis was based on the fact that for the last six years the teachers have used an IWB continuously, after undergoing comprehensive training and integrating the computer in their teaching for more than 10 years.

The attributes of interaction in lessons taught with an IWB were examined through methodical, structured observations. Additionally, we examined the students' attitudes towards learning with an IWB. We examined whether after the students' experience with an IWB for several years their enthusiasm wanes. The specific research questions were:

(1) What is the frequency of use of the various IWB tools in science lessons?
(2) What are the attributes of the interaction in these lessons?
(3) What are the students' positions regarding integrating the IWB in lessons?

Methodology

The research population

The research was conducted with the cooperation of two science teachers from two elementary schools in the south of Israel. Both schools belong to the medium-high socio-economic level, and for the last eight years have participated in the "smart class" project. The project included the integration of laptop computers and IWBs in classes as well as training the teachers to teach with technology. The two teachers who taught the students in this study have about 15 years of experience teaching sciences. They participated in comprehensive technical and pedagogic training to integrate IWBs and they have taught using the IWB and computers for six years consecutively. The two teachers participated in the study as part of their master's degree curriculum in scientific education.

The participating students studied using an IWB for five years and therefore learning with an IWB is not new to them. A total of 62 6th grade students (aged 11–12) participated in the study.

The research tools

(a) A structured observation was performed to examine the use of technological tools, the learning organizations and the interaction attributes. The observation, taken from the study by Manny-Ikan, Tikochinski, and Bashan (2013) included notation of most of the situations occurring every 3–5 min in the class. The observation enabled measuring the periods of time in a lesson in which the teachers create different interactions with the students (with and without technology), the various learning organizations in the lessons (plenum, group, individual, organizational) and the length of use of the IWB tool and the computer. The percentage of use was calculated by measuring the time during which the IWB tools and the laptop computers were used during the lesson. The learning organization was characterized by measuring the times when the class worked in groups, in the plenum, individually, or when the students presented their work to the class.

In order to determine the type of interaction at each stage of the lesson, we relied on the article by Beauchamp and Kennewell (2010), and ranked the interaction on a four-rank scale:

(1) Without interaction between the teacher and the student – the lesson content was given by the teacher who lectures and demonstrates. The students usually watched or read the text that the teacher presented using the IWB and did not respond actively.
(2) Teacher-focused limited interaction – the lesson structure and most of the content are determined by the teacher. The students are asked closed questions which have an unequivocal answer, and therefore the interaction is limited. The teacher used this type of interaction in order to teach facts and skills.
(3) Open interaction with a common teacher-student focus – the entire lesson structure is determined by the teacher, but not all the content. The teacher called a discussion, and also took into account the students' answers, but the objective of the discussion was to encourage the students to adopt the accepted view regarding a specific concept or content. In this type of interaction, the teacher's purpose was to develop knowledge regarding the concepts and the processes.
(4) Student-focused open interaction – dialogic interaction – the teacher and the students together contributed to the lesson structure and its content. The objective of the discussions in the lesson was to propose diverse points of view with in-depth understanding of the concepts and the processes. The teacher usually reacted reflectively to the students' comments, with the goal of applying concepts and processes.
(5) Students' questionnaire: The questionnaire was taken from the work by Perry (2008) and included 25 statements that examined the students' attitudes regarding learning with technology. The questionnaire examined diverse aspects such as the desire to further and expand horizons, and pleasure from learning and interaction with the teacher and the students. The questionnaire was validated by experts and all the students noted the degree of their agreement with each statement on a five-rank Lickert scale (from fully agree = 5 to completely disagree = 1). The questionnaire statements appear in the appendix.

The research process

The study was conducted in 2014 for two months in each class, in two schools. One class studied the subject of the "circulation system in the human body" and the other class studied the subject of

"food, nutrition and the human digestive system". The two teachers received pedagogic and technical instruction and each prepared their subject so that the teaching included the use of the IWB. Table 1 presents an example of two lessons on the subject of the circulation system.

During the teaching an experienced science teacher observed and documented the lessons using structured observation. The lesson was divided into units of 3–5 min and the observer noted events and the type of IWB tool used for each unit of time, the learning organization and the type of interaction. Prior to the observation the observing teacher was instructed regarding the observation structure, the type of notation, levels of interaction and so on. Examples of various possible classroom situations were analyzed together with the observer before the observations. For example, if the teacher asked a closed question to which there is one correct answer and immediately shifted to the next topic without developing a discussion, this situation will be marked as teacher-focused interaction. The observer noted all the situations occurring during the lesson. When it was difficult to determine the type of interaction, two researchers later decided on this separately, according to the description of the situation.

In total, observations were conducted of 26 lessons (15 in one class and 11 in the other class). After studying the subject the students completed a questionnaire that examined the attitudes towards the learning and teaching with an IWB.

Table 1. An example of two lessons that integrate an IWB.

	The activity	Time (min.)
Lesson 1: Introduction to familiarity with the circulation system – the students' perception	a. Discussion of the question, what is the circulation system. The students' answers were noted on the IWB and the board page was saved for later to compare the answers to be received from students at the end of studying the subject	10
	b. Screening on the IWB from a digital book that opens the subject of the blood circulation system	10
	c. The students were divided into groups of four. Each group received a laptop computer and summarized the components and the roles of the blood circulation system on the basis of the previous discussion and personal knowledge, and saved the file on the class web site	20
	d. A representative from one of the groups presented the presentation on the IWB of one of the groups	5
Lesson 2: Continuation – developing the understanding and the students' perception of the circulation system	a. Watching a YouTube filmstrip that was edited using EduTube that presents the components of the circulation system and their location in the human body	5
	b. Using a presentation and pictures screened on the IWB about the components of the system and their location The teacher explains	10
	c. Individual work with the laptop. Each student is asked to access the class site and correct the presentation the group built in the previous lesson, to add what is lacking, and to save the file under their name in the class web site	10
	d. A number of students, each in turn, presented to the class on the IWB the corrected presentations and explained what they corrected and added while emphasizing using a smart pen	20

Data analysis

(a) The observation findings from the lessons: Each lesson was divided into time units according to its various attributes: those pertaining to the use of technology, those associated with the organization of learning in the lesson, and those pertaining to the attributes of interaction. These times were calculated for each of the categories of analysis separately in each of the 26 lessons in which the observations were conducted. At the next stage the averages were calculated that summarize all the observation data from all the lessons for each of the attributes. The raw observation sheets were duplicated and analyzed separately by two researchers working in the field of integrating technology in teaching sciences. Thereafter, a shared discussion was held to reach full agreement regarding the way of interpreting the findings for each of the attributes described.

(b) The students' questionnaires: Analysis of the factors using the varimax method with orthogonal rotation was performed for all 25 statements pertaining to the students' attitudes. Three main categories were located in this analysis, as presented in Table 5. The first category included eight statements dealing mainly with pleasure with the method of learning. The second category included seven statements pertaining to enrichment and furthering learning. The third category included nine statements pertaining to active learning and interaction. The reliability of all three categories was high (see Table 5), and the reliability of the entire questionnaire was $\alpha = .78$. The averages and standard deviation of the students' answers were calculated for each of the questionnaire categories.

Findings

The frequency of the use of the IWB tool

Table 2 presents the average frequency of the use of the different IWB tools and laptop computer in class. Clearly, in different lessons the rate of use of certain tools was more dominant, but the reference here is to the average frequency of the use of diverse tools during the 26 lessons. In general, it was clear that the use of technology was dominant, and lasted for most of the lesson time (more than 80% on average). The teachers demonstrated skill and confidence in the use of the IWB, and used the tool for different purposes during the lesson. At the same time, most of the use was in manipulating the notation, the marking and the emphasis, or dragging text and pictures, as well as screening presentations or filmstrips. Structured objects, unique to the IWB, such as a stopwatch or magnifying glass, were hardly integrated in the teaching. Similarly, the teachers barely saved the IWB pages in order to explore them in various stages of teaching and further learning.

Learning organization and types of interaction

Table 3 shows that the whole class learning occurs for about half the average lesson time. Only about 20% is devoted to individual learning by students to perform the assignments or exercises, and far

Table 2. The frequency of use of technological tools during a lesson ($n = 26$).

Types of technological tools	Average percentage of time in a lesson	SD
Text manipulation – notation and emphasis in different colors	24	6.2
Picture manipulation – notation, marking and emphasis	5	2.3
Dragging and releasing words, sentences, or pictures	6	5.2
Screening pictures, presentations, diagrams, or filmstrips on the IWB	21	5.3
Saving the IWB pages for surfing amongst the pages and further learning	6	2.0
Combining ready objects in the IWB (magnifying glass, stopwatch …)	1	1.2
Individual or group work with a laptop	14	8.9
Raising files and writing in the class forum	5	2.0
Total	82%	

Table 3. The frequency of the learning organization attributes in IWB lessons ($n = 26$).

Learning organization	Average percentage of lesson time (SD)	Sample activity
Organization	8.5 (4.3)	The teacher divides the students into work groups
Plenum	49.9 (7.7)	Teacher's explanation, presenting – pictures, diagrams or filmstrips
Individual	21.6 (10.4)	Students carry out personal assignments in the digital book with a laptop
Group	11.7 (7.7)	The students develop a presentation and raise it to the class forum
Individual + plenum	8.3 (6.2)	A student presents the diagram he developed on the IWB to the whole class

Table 4. Distribution of types of interaction in the classroom when working with an IWB ($n = 26$).

Type of interaction	Average percentage of lesson time (SD)	Sample activity manifesting the interaction
Without interaction	17.5 (10.6)	The teacher explains using a presentation, pictures or filmstrips
Teacher-focused	48.1 (7.6)	The teacher invites students to the IWB and asks to drag suitable words to the prepared chart
Joint teacher-student focus	25.3 (4.8)	The teacher arouses a discussion over questions such as why do they think one does blood tests?
Student focus	9.1 (8.6)	Students react in the class forum to the products of other students presented in the class web site

Table 5. The student's attitudes towards learning using an IWB ($N = 62$).

The category	Statement number	Examples of statements included in the category*	*M*	SD	*α*
Pleasure from the learning	8	14. I like the way the teacher teaches 1. I enjoyed preparing the assignments	4.11	.69	.83
Enrichment and deepening knowledge	7	12. I would like to learn the subject for more hours 24. I enjoyed documenting the learning at every stage	3.69	.84	.80
Active and cooperative learning	9	4. I learned much from the discussion and the students' questions and their answers 20. I felt I was given the opportunity to express myself	4.02	.67	.71

*All the questionnaire statements are detailed in the appendix.

less than that to group learning or to the student's presentation before the class. Accordingly, above 65% of the average lesson time is conducted in interaction which is under the teacher's control and is teacher-focused, as can be seen from Table 4. Only about 25% of the lesson time is conducted in interaction with the shared focus of the teacher and the student. The interaction that is student-focused occurs in less than 10% of the lesson time on average.

Students' attitudes to the IWB

The students' attitudes toward learning with an IWB are presented in Table 5. The high averages for the three tested categories indicate great enthusiasm and satisfaction. The students' report of having enjoyed studying using the IWB ($M = 4.11$) was prominent, but they also thought that the IWB contributed to their learning, enriched them, and also advanced the active learning and participation in class ($M = 3.69$ and 4.02 respectively).

Discussion

The promise embodied in the contribution of the IWB to learning has been studied for more than a decade, but the findings are not unequivocal. Nevertheless, the penetration of the IWB to classes is accelerated in many countries. This study focused on examining the contribution of the IWB to whole

class interaction. We found that the dialogic interaction between the teacher and the students was very limited. Most of the time the teacher is at the focus of the lesson, determines the content, the structure and the pace, and less space is afforded to the students' contribution. A large part of the teaching occurs in the plenum, mainly frontally.

It is important to emphasize that the observations were conducted of teachers who have five years' experience teaching with an IWB. Analysis of the lessons did indeed show that most of the lesson took place with ongoing use of diverse IWB tools, although most of the time the teachers used tools such as manipulating texts and presentation that supported teacher-focused interaction. Similar findings were found among teachers in Australia who used IWB mainly for presentations and for explicit instruction (Kearney & Schuck, 2008). In general, our findings support other studies that emphasize the paradox of the use of innovative technological means for traditional teaching (Aflalo, 2014; Hennessy et al., 2007; Nachmias, Mioduser, & Forkosh-Baruch, 2010). Gray (2010) notes cynically that it is not a coincidence that the IWB became the most popular technological application in school, since it is compatible with the control teaching perception.

It can be argued that the five years of experience of teaching with an IWB is a brief period of time for attaining pedagogic change, but it is important to emphasize that the entry of IWB to schools comes several years after the introduction of computers. The schools in our research already underwent a lengthy process of technology assimilation. Technology in the class changes rapidly, and the teachers are demanded to adapt themselves to the current digital world in which five years is considered several generations.

In reviews by Moss et al. (2007) and Somekh et al. (2007) who evaluated the IWB project in England, it was claimed that pedagogic change would only occur after the full use of the IWB for at least one year. In this study we found that even after five years of teaching with the IWB the teachers are only at the first stage, or perhaps at the start of the second stage, of assimilating the use of the IWB, as described in the literature review. In other words, teaching is mainly traditional using new means. An attempt was made to engage the students, but no intense change in the teaching approach occurred. In fact, the teaching with the IWB, as presented in the study, is no more than an expensive electronic method of frontal teaching that can mostly be achieved using a projector connected to a laptop.

These discouraging findings raise questions regarding the contribution of the IWB to interaction in the class. It is therefore clear from here, and also from other studies, that the actual use of the IWB and the duration of use does not assure the existence of quality interaction (Hennessy et al., 2007). Moreover, concern exists that the IWB will cause withdrawal in classroom interaction. As a tool intended primarily for whole class teaching, it can raise the frontal teaching and will not further diverse learning organization in the classroom, that are likely to contribute to the level of interaction (Lewis, 2003; Somekh et al., 2007).

It is important to stress that teachers use diverse interactions during lessons according to the teaching objectives. Diverse types of interaction are found in different lessons, but analysis of a large number of successive lessons, as was performed in this study, provides a general picture regarding the focus of the interaction in the classroom and manifests the teachers' perception of teaching.

The potential influence of the IWB on pedagogy in class is likely to be tremendous, if only for the fact that in contrast to laptop computers this is a technological tool that the teachers can use for daily teaching. Therefore, the main question is how can the IWB be used intelligently for interactive learning?

According to Lee and Winzenried (2009) the IWB can lead to pedagogic transformation or barely affect it. The change will occur only if several critical factors exist. These researchers aver that the repeated failures of integrating technology in education stem from the absence of some factor, such as the teacher's preparedness, the class availability, quality infrastructure, ongoing technical support, financing and quality leadership. However, despite the existence of these attitudes in the current study, the expected results regarding the pedagogic interaction in the class were not obtained. If so, what is missing?

The IWB is perhaps not the most suitable tool for promoting interaction in the class. There seems to be agreement over its contribution as a powerful representative tool but the question of its contribution to pedagogic interaction remains open. There are reports that it contributes to promoting interaction in class (BECTA, 2008; Blue & Tirotta, 2011; Slay et al., 2008) but as noted, there are also contradictory reports regarding superficial interaction in whole-class teaching (Smith et al., 2005; Somekh et al., 2005).

Smith et al. (2005) discern between technological interaction that refers to the physical interaction with the tool, and pedagogic interaction that pertains to interaction between students and teachers. Our findings indicate that there was considerable interaction of students with the IWB, but the dialogic interaction was not notable. These findings, together with our findings regarding learning organizations, according to which most learning was frontal and occurred in whole class forum, contradict the claim that the IWB is adapted particularly to support dialogic pedagogy, and that it expands the possibilities for dialogue and cooperative learning (Hennessy & London, 2013).

On the other hand, the key problem may not be connected to IWB suitability to class interaction. The main factor that can lead to pedagogic change, while exploiting the potential embodied in technology, may pertain to the teachers' perception of the interaction in class. It seems that the teachers' understanding of the interaction with the students, which is connected to deep understanding of the learning process, should first be established (Fullan, 1993; Tanner et al., 2005), understanding which is likely to alter the traditional teaching approach (Alexander, 2004; Moyles, Hargreaves, Merry, Peterson, & Esarte-Sarries, 2003).

Pedagogic transformation will not occur solely due to the introduction of the IWB to the classroom, and the responsibility for achieving the learning objectives using the IWB is the teachers' (Twiner, 2010). The teachers' pedagogic perceptions and their preferences that develop from their previous experience, shape the way in which they will use every educational tool, including the IWB. A new approach can develop through investment in the teachers' professional development and only with their agreement (Hennessy & London, 2013).

Most studies on the IWB refer to whole class interaction. But the IWB has been found to advance learning in groups even when the teacher is absent (Warwick, Mercer, Kershner, & Kleine S, 2010). Activities can be held that enable several students to work with the IWB simultaneously and in cooperation. Group learning, with an IWB, is likely to promote dialogic interaction and therefore it is important to research more the group and cooperative learning with an IWB.

In this study we also examined the students' attitudes to learning with the IWB. We found that despite them studying already for five years continuously with an IWB, they are still very enthusiastic. These findings contradict Lacina's (2009) claim that the students' enthusiasm with IWB learning is short-term. The students in the current study even state, contrary to the observation findings, that the IWB encourages active learning and interaction. These findings are similar to those obtained in other studies in which the students reported enjoyable and innovative learning (BECTA, 2008; Morgan, 2008) as well as active learning and more interaction in class (Higgins et al., 2007; Wall et al., 2005). The students' enthusiasm with the IWB may stem from the fact that this is a very visual, dynamic and attractive board. In any case, the students' attitudes and their motivation could have considerable influence on their learning (Shumow, Schmidt, & Zaleski, 2013), therefore it is important to harness this enthusiasm with the IWB to interactive learning.

The research limitations

A key limitation in this study is the sample size. Only 26 lessons were observed, two teachers in two classes in which only 62 students studied. Therefore, it is not clear to what extent one can draw conclusions from these findings regarding teachers and students in other schools around the world. There is no doubt that further studies are needed, but if these findings intensify, the degree to which the board may enjoy its name – an interactive board – should be examined seriously.

Another limitation is that the current study lacks a control group regarding teaching without an IWB. The teachers who participated in the study teach only using an IWB. Another limitation pertains to the difficulty to estimate the specific impact of the IWB. In this study, similar to other studies, teaching with an IWB was combined with using laptops. Moreover, measuring the interaction times in the class does not perforce indicate its quality. In another study that we are currently executing, we also analyze in depth the attributes of the dialogue between the teacher and the students at diverse stages of the lesson, from the sequence of the discussion and its contents, the types of questions, and the nature of the tasks, in order to better evaluate the quality of the interaction. Such in-depth analyses can be conducted on a relatively small number of lessons. The current study was intended to explore, in a broader and more general manner, the attributes of the interaction in 26 lessons that together with tracking the learning organization in the class, present a fairly reliable general picture.

In summary, teaching using an IWB does not indicate dialogic interaction, according to the current study. These findings raise questions about the place and role of the IWB regarding advancing pedagogic interaction in the whole class. The key would seem to lie in the teachers' perceptional change in respect of interaction and learning. This change, together with the advancement of the group and cooperative learning with an IWB, is likely to increase the impact of the IWB on pedagogic interaction.

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Appendix 1. Questionnaire on student' attitudes

Category	Statement number	Statement content
Pleasure from the learning	1	I enjoyed preparing the assignments
	6	Reversed: I feel tired and am fed up of studying this subject
	7	Reversed: I prefer to study this subject in a different manner
	8	The teacher taught in a way I liked
	9	I liked studying the subject
	13	Reversed: I did not spend enough time doing the assignment on the subject
	14	I liked studying with an IWB
	15	I enjoyed writing about the subject
Enrichment and deepening knowledge	5	I used the Internet to learn more about the subject
	10	I used information banks to study the subject in greater depth
	11	I want to continue studying the subject beyond the science hours devoted to the subject
	12	I would like to learn the subject for more hours
	16	I read about the subject
	19	I feel I enriched my writing and reading after studying the subject
	24	I enjoyed documenting the learning at every stage
Active and cooperative learning	2	I would like to study other subjects using a IWB
	4	I learned much from the debate and from the students' questions and answers
	17	I enjoyed reacting to the students' opinions
	18	I enjoyed talking and participating in lessons with an IWB

(*Continued*)

Continued.

Category	Statement number	Statement content
	20	I felt I was given the opportunity to express myself
	21	The activity in the lessons with the IWB contributed to learning
	22	The teacher's guidance encouraged me
	23	I prefer studying the subject with my friends' help
	25	I feel more involved and active when studying with an IWB
Does not pertain to any dimension	3	I made an effort to do better