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The Effect of Smart Boards on the Cognition and Motivation of Students

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Abstract

In recent years the research literature has explored technological developments in varied areas that measure change. The current study focuses on the smart board, and its purpose is to examine its effect on the school system. The study was conducted via a questionnaire completed by 130 respondents (boys and girls) in the fifth and sixth grades of two elementary schools in Jerusalem—Efrata and Tali Gilo. Smart boards were introduced in these two schools in recent years.

We hypothesized that smart boards improve teaching, based on the teaching measures developed by Nira Hativa of Tel Aviv University: order and organization, level of clarity, interest, and general level of satisfaction. The study's significant finding is that the greatest improvement since the introduction of smart boards is in the variable of clarity, and a significant difference was found in the favor of sixth grade students. Additionally, a significant difference was found in the variable of interest, in favor of the girls. All four variables appear to be interrelated, and each contributes to the student's success and to improving the student's learning process.

The research findings illuminate the contribution of technology to teaching, through a case study of smart boards, in the dimension of clarity, found by the study to be a significant criterion of good teaching. Examination of the various technological tools in light of their contribution to the research-proven dimensions of outstanding teaching might enhance the pedagogical contribution of technological developments to teaching.

Keywords: computer-assisted communication, technology, smart board, motivation of students

1. Introduction

1.1 The "Tool Revolution Period"

In the last thirty years, the Israeli Ministry of Education has announced 12 programs aimed at integrating information technologies in the schools. The Israeli Ministry of Education recognizes the significance of assimilating advanced teaching technologies and their utilization (Dror & Gershon, 2012). In schools and in academia, various technological tools are used and students are "digital learners", a homogeneous generation of proficient users of digital technology. Naturally, the definition is not unequivocal and it changes over the years and in different societies (Esther et al., 2015). Studies that examined the use of technology in schools and its effectiveness found that use of technology is efficient for students (Anderson & Dexter, 2005). A survey held in secondary schools explored the satisfaction of students with use of technology at their schools, and its results showed that 72% of students think that each of the technologies introduced in their school helps understand the material taught in class. Use of assistive technologies that help convey the material visually is highly appreciated by students. They see these technologies as efficient pedagogical vehicles for conveying the study material through tools that create a great deal of interest in the lesson (Dror & Gershon, 2012).

Dori and Kurtz (2015) checked to what degree the use of technological means contribute to understanding the study material and to students' motivation. The research findings indicate that most students report that learning in a technological environment boosts their motivation and enhance their learning experience. The major contribution of technology as perceived by students is in increasing access to a variety of tools that contribute to understanding the study material, to organization of the information, to efficacy in carrying out assignments, and to development of knowledge.

1.1.1 Technological Changes in the School System

Many types of varied technologies were introduced in the schools with the increase in digital use in the world in general and in the school system in particular. The most common tools in the school system are the class projector, the school website, and the class interactive whiteboard. These help students understand the material and create interest in the lesson (Dror & Gershon, 2012).

A study that examined the written comprehension of students during online reading on the computer versus reading from paper showed that online reading was more efficient and even generated higher grades (Huang, 2014). Shan (2013) investigated the introduction of tablets to the school system and their impact on students with various levels of ability, and found that the tablet enables the weaker students to hear the texts at their own pace without feeling insecure or embarrassed at having to ask the teacher to review the material. Moreover, the findings show that the tablet enables each student to hear the precise pronunciation of the words and thus raises their self confidence in speaking correctly to the class. Another study conducted in the US, in schools that introduced laptops in the classrooms, found that the integration of laptops in class has a positive effect on students' learning and on their participation in class. Nevertheless, the study suggests that teachers should increase their technological knowledge and improve it in order to enhance teaching in class (Keengwe, Schnellert, & Mills, 2012).

1.2 The Smart Board

In a project fun by the "Kadima-Mada" (Forward-Science) organization, in which smart classrooms were activated in schools, four models were introduced showing the development of technology use in the school system. The change began with build-up of the teacher's station in class, including infrastructure for use of a projector and a computer linked to the internet. Later, an interactive whiteboard was added, as well as a computer for each group of students, and finally, in addition to the smart board each student also received a computer (Blau, 2012). In the 2010/11 school year a significant change was effected in the school system, as some school classrooms became "smart classrooms". The change was carried out in the understanding that the interactive whiteboard can lead to a pedagogic change and improve students' achievements (Blau, 2012). Use of smart boards includes possibilities offered by the regular whiteboard, together with other means that enable interactive teaching and learning (Manny-Ikan, Dagan, Tikochinski, & Zorman, 2011), as well as connecting to students' computers from home (Hadad & Gazit, 2012).

Blau (2011) listed three characteristics that transform the smart board into an efficient pedagogical tool:

A. Divergent learning—the ability to skip from pages on the screen to the internet in a structured and fluid manner. This ability simulates the associative organization of the student's brain and contributes to the organization and clarity of the lesson as perceived by the student.

B. Smart boards serve as a cognitive tool that expand students' mind and facilitate supported joint thinking. Since some of the mental load is transferred from the students to the board, they are free to engage in higher thinking processes.

C. Interactive learning—smart boards enable interactions between study contents and the students themselves, both face-to-face and online.

Notably, all teachers who teach with a smart board receive designated training, in which they learn how to operate it and how to teach with it, for example matching the text to visual presentation or avoiding excess explanations.

We found support for previous research findings in interviews conducted as well, for instance, with a teacher at the Efrata elementary school in Jerusalem, who stated that before smart boards schools used chalkboards and whiteboards. She claimed that regular boards are less convenient and less effective for both teachers and students, and that despite the technical difficulties involved in operating the board, use of smart boards presents the study material and even demonstrates it more efficiently. With smart boards it is possible to show short films in class, as well as pictures and pages from the textbook which best illustrate the material to the students, and thus students better understand the lesson and also take an active part.

1.2.1 Advantages and Disadvantages of the Smart Board

Many studies show that students' achievements increase significantly ocne interactive whiteboards are used for teaching purposes. Teachers who use smart boards in class report a rise in the quality of teaching. This rise is facilitated by the ability to conduct lessons that combine multimedia, which attract the students' attention and

imagination in creative ways. The interactive whiteboard has the advantage of adapting the manner in which the study material is conveyed to the students' personal learning style (Becker & Lee, 2009).

The major contribution of smart boards is that they afford choices on various topics, contribute to understanding the material, to developing knowledge, organizing information, self-efficacy in carrying out assignments in a friendly environment, increase the efficiency of learning at any location and contribute to it, as well as to the representation of products that generate a sense of success, pleasure, and contribute to a more creative and higher standard learning product (Dori & Kurtz, 2015).

The "Smart Project" study that integrates smart boards in teaching and learning examined six schools with the intention of exploring the effect of combining technology in pedagogy on teachers and students. The research findings indicate that smart boards contribute significantly to both parents and students, and therefore it is necessary to add smart classrooms throughout the entire school system (Manny-Ikan et al., 2011). Clark (2012) claimed that the benefit of smart boards is that teachers can save comments and explanations on the smart board, and thus record lessons for future use by students who missed class due to an absence or illness.

However although many studies show that use of smart boards improves learning and makes teaching meaningful, a study that examined the ability to solve problems and thinking skills among students in smart classrooms and students in classrooms with regular boards, found that it was the students who study in classrooms with regular boards who were better off. Students who studied in smart classrooms claimed that there were often technical problems and that the teachers were not sufficiently proficient. Nonetheless, in a questionnaire on attitudes to learning, students in the smart classrooms claimed that the smart board encourages motivation to learn, raises the level of concentration, and has a strong effect on behavior (Shuck & Kearney, 2007).

In conclusion, the disadvantages and advantages appear to be rooted in the teacher and students' use of the smart board. The efficiency of smart boards depends on wise use by the teacher, with the aim of making the material accessible for the students. Teachers must teach how to use smart boards, prepare themselves well for each lesson, and use all the aides available to them (Hadad & Gazit, 2012).

1.3 The Good Teaching Model

Avni and Rotem (2013) claim that learning becomes meaningful when it has value and significance for students, matches their cognitive abilities, and shapes students' reality, personality, skills, development, and future.

Hativa (2015) reviewed the areas that reflect the nature of good teaching. Her review shows that good teaching is divided into two aspects, the cognitive-thinking aspect and the affective-feeling aspect. The cognitive-thinking aspect of good teaching includes order and organization of the lesson and also clarity and interest. Organization of the lesson is when the student follows the teacher, listens to the course of the lesson, understands what has been learned up to now and what will be learned in the next stage. The concept of clarity refers to presenting explanations that are clear and understood by the students, let them understand the subject material and apply it. Interest means maintaining the students' concentration and motivating them to learn and understand.

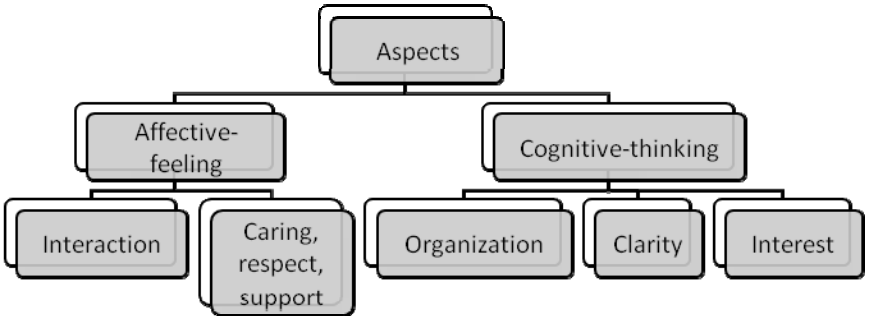

Figure 1. The model of good teaching (Hativa, 2015)

In our study, we will utilize Hativa's principles on the cognitive-thinking aspect of the dimensions of good teaching, and explore whether students studying in classrooms with a smart board sense these principles during lessons. This in order to understand whether smart boards, as a means of improving teaching, indeed make classroom studies more efficient with regard to the dimensions of outstanding teaching: organization, clarity, and interest (Hativa, 2015; Dror & Gershon, 2012; Davidivitch & Yavich, 2016).

Our main goal is to examine the effectiveness of using smart boards as a mechanism of change, to explore students' evaluation of it and its effect on them, and to investigate how smart boards differ from any other board work. Additionally, we wish to examine whether the use of smart boards indeed makes learning more interesting, and whether it facilitates the classroom learning process.

In light of the literature review, our current hypotheses are:

1) Use of smart boards improves order and organization among elementary school students.

2) Use of smart boards improves the level of clarity among elementary school students.

3) Use of smart boards improves interest among elementary school students.

4) Use of smart boards improves the overall level of satisfaction among elementary school students.

2. Method

2.1 Research Population

The sample included 130 elementary school students from two different schools in Jerusalem—the State Religious Tali Gilo School and the Efrata School. About half the students were in the fifth grade and half in the sixth grade, 77 boys and 53 girls. Of all the participants, 52.3% studied at Efrata and the rest at Tali-Gilo.

2.2 Research Tools

In order to evaluate the students' overall satisfaction with smart boards and the level of order and organization, clarity, and interest, the Students' Attitudes to Meaningful Learning in an Innovative Environment questionnaire (Dori & Kurtz, 2015) was administered. The original questionnaire was used online, and the current study used a printed version. The number of questions was adapted to the current hypotheses. The questionnaire includes 31 items and the students were asked to note the accuracy of the statements on a scale of 1—"not at all" to 5 "very strongly". The questions were categorized by the four criteria examined in our research hypotheses. In addition to the questionnaire for the students, personal interviews were also held with teachers at the schools who use smart boards to teach.

2.3 Procedure

The questionnaire was administered at both schools. At first the students received an explanation about how to complete the questionnaire, and then they were asked to complete it voluntarily. The students' replies were statistically analyzed.

2.4 Research Design

Independent variable: 1) Gender; 2) School; 3) Grade level.

Dependent variable: 1) Order and organization; 2) Clarity; 3) Interest; 4) Overall satisfaction.

2.4.1 Statistical Analysis

Based on the questionnaire data, we conducted a Pearson correlation examining the relationship between the various variables in the research hypothesis: order and organization, clarity, interest, and overall satisfaction. Gender-based differences, differences between 5th and 6th grade students, and differences between schools were also examined. We used an analysis of variance to check for the variable that had the most effect on the change that occurred upon switching to smart boards.

3. Results

In order to examine the relationship between use of smart boards and student evaluations of the dimensions of outstanding teaching (Hativa, 2015), a test was held to check Pearson correlations between the variables. Analysis of the results showed a significantly positive correlation between order and organization—and level of clarity ($p<0.01$). The higher students' level of order and organization the higher their clarity. Moreover, a significantly positive correlation was found between order and organization—and level of interest ($p<0.01$). The higher students' level of order and organization the higher their interest. Similarly, a significantly positive correlation was found between level of clarity and level of interest ($p<0.01$). The higher the interest the higher the clarity. Another significantly positive correlation was found between level of overall satisfaction and level of

order and organization ($p<0.001$). The higher students' level of order and organization the higher their overall satisfaction. Moreover, a significantly positive correlation was found between the level of overall satisfaction and the level of clarity ($p<0.01$). The higher the level of clarity the higher the overall satisfaction. Similarly, a significantly positive correlation was found between the level of overall satisfaction and the level of interest ($p<0.01$). The higher the interest the higher the overall satisfaction (see Table 1).

Table 1. Pearson correlations between the research variables for their strength, direction, and significance

	Order and organization	Level of clarity	Level of interest	Overall satisfaction
Order and organization	-			
Level of clarity	.619**	-		
Level of interest	.590**	.715**	-	
Overall satisfaction	.670**	.801**	.786**	-

**p<0.01

In order to explore which of the measures affected by smart boards showed the most improvement, a one-way analysis of variance for repeated measures was conducted. Analysis of the results indicates a significant difference between the areas of improvement that occurred as a result of using smart boards (F (2.068, 266.735)=18.074, $p<0.01$). Examination of the source of the differences' significance was performed using a Bonferroni post hoc test, which found that the significantly largest improvement was evident in the area of clarity. It is also possible to see that the improvement in overall satisfaction is greater than the improvement in order and organization and in level of interest. No significant difference was found between improvement in the areas of order and organization—and level of interest (see Figure 2).

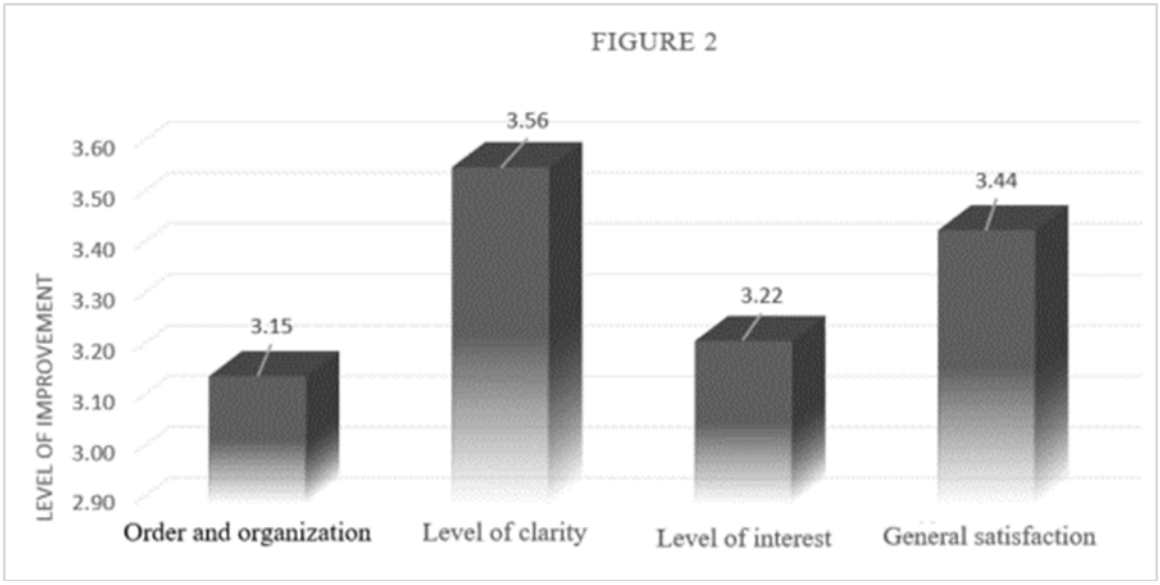

Figure 2. Means of improvement in the various areas as a result of using smart boards

In order to refute alternative explanations, gender-based differences in the areas affected by smart boards were examined. A t-test for independent samples showed no significant difference between boys and girls in the level of order and organization (t (97.745)=1.412, $p>0.05$) or in the level of clarity ($t_{(128)}$=1.479, $p>0.05$). However, a significant gender-based difference was found in level of interest ($t_{(128)}$=2.988, $p<0.01$), with the level of interest higher among girls than among boys. Nonetheless, no significant difference was found between boys and girls in the level of overall satisfaction ($t_{(128)}$=1.228, $p>0.05$) (see Table 2).

Table 2. Means and standard deviations in each area by gender

	Boys		Boys	
	n=77		n=78	
Variable	M	SD	M	SD
Order and organization	3.032	1.014	3.321	1.225
Level of clarity	3.479	0.738	3.679	0.789
Level of interest	3.044	0.778	3.474	0.847
Overall satisfaction	3.376	0.618	3.525	0.769

A t-test for independent samples was also held in order to examine the differences between schools in the areas affected by the smart board. The findings show no significant difference between the schools in the level of order and organization ($t_{(128)}$=1.968, p>0.05), level of clarity ($t_{(128)}$=0.919, p>0.05), level of interest ($t_{(128)}$=0.046, p>0.05), or level of overall satisfaction ($t_{(128)}$=1.186, p>0.05) (see Table 3).

Table 3. Means and standard deviations in each area by school

	Efrata		Tali-Gilo	
	n=62		n=68	
Variable	M	SD	M	SD
Order and organization	2.952	1.108	3.331	1.088
Level of clarity	3.625	0.791	3.502	0.737
Level of interest	3.216	0.763	3.222	0.895
Overall satisfaction	3.511	0.634	3.369	0.726

The differences between the fifth and sixth grades in the areas affected by smart boards were examined with a t-test for independent samples. Analysis of the results found no significant difference between the grades in the level of order and organization ($t_{(128)}$=0.094, p>0.05), level of interest ($t_{(128)}$=0.890, p>0.05), or level of overall satisfaction ($t_{(128)}$=0.485, p>0.05). The only significant difference found between the grades was in the level of clarity ($t_{(128)}$=2.340, p<0.05). The level of clarity among sixth graders was higher than among fifth graders (see Table 4).

Table 4. Means and standard deviations in each area by grade

	Fifth grade		Sixth grade	
	n=66		n=64	
Variable	M	SD	M	SD
Order and organization	3.159	1.259	3.141	0.941
Level of clarity	3.409	0.865	3.717	0.608
Level of interest	3.155	0.927	3.285	0.720
Overall satisfaction	3.408	0.762	3.466	0.600

4. Summary, Discussion, and Conclusions

When attempting to investigate the effect of introducing smart boards as a mechanism of change in the school system, we focused on the principles presented by Hativa (2015), on the cognitive-thinking aspect of methods of good teaching. Our hypotheses, whereby use of smart boards improves order and organization, level of clarity, interest, and level of overall satisfaction among elementary school students, were derived from this aspect.

Of our four hypotheses, the second was significantly confirmed. The analysis of variance conducted indeed indicated a significant difference in the level of improvement as a result of using smart boards, but the post hoc analysis showed that a significantly meaningful improvement was only evident in the area of clarity, thus confirming the second hypothesis. In contrast, the first, third, and fourth hypotheses were refuted, as in the other areas the greatest improvement was evident in overall satisfaction.

In order to refute alternative explanations, differences in gender, grade (age), and school (religiosity) were examined. There appears to be a gender-based difference in areas affected by smart boards, such that the level of interest among girls is significantly higher than among boys. A study that examined inter-gender differences found that girls achieve greater scores on personal, social, and emotional development. They are more diligent in solving problems, concentrate better, understand what is correct and what is incorrect (Fisher, 2013).

Upon examining the differences between grades (age), analysis of the results shows a significant difference between grades in level of clarity, such that the level of clarity among sixth graders is higher than among fifth graders. It may be assumed that this difference stems from the natural maturing that occurs between the fifth and sixth grade.

The Pearson correlations examining differences between schools show that all the variables have a mutual effect. The higher the order and organization the higher the clarity and interest, and the higher the interest the higher the clarity, such that the higher the order and organization, clarity, and interest, the higher the students' overall satisfaction. This indicates that when students follow the teacher and are attentive to the course of the lesson, clearly understand what has been taught to date and what will be taught in the next stage, their level of interest will be higher.

The findings show that the level of clarity also rises with order and organization. A possible explanation is that the more the student is organized and concentrated on the lesson, the clearer the study material will be for him or her. This also leads to a positive correlation between interest and clarity, where the higher the level of interest, i.e., when the student is concentrated and interested in the study material, the higher the level of clarity. Obviously, the higher the student's order and organization, clarity, and interest, the higher his or her overall satisfaction. Hence, it seems that all four variables of order and organization, clarity, interest, and overall satisfaction, derive from each other, such that each contributes to the student's success and achievement improvement. All the above is compatible with the research literature presented in the Introduction. Many researchers have found a relationship between the introduction of technology in general and of smart boards in particular in schools, and students' level of interest.

4.1 Research Limitations

First of all, the student population sampled in the study was taken in its entirety from the same geographical region, Jerusalem, and has the same religious background, which might indicate uniformity in certain aspects. Secondly, the students are elementary school students in grades 5-6. At this age, children's mental and physical maturity is not yet sufficiently developed, and therefore sometimes when asked in general about their studies they answer immaturely, not necessarily reflecting actual circumstances. The structure of the questionnaire is also problematic. The responses presented to the students included five options, and the students tended to choose the neutral answer.

Notably, the students who participated in the study had never studied with a regular whiteboard, and thus this study did not show a comparison between the types of boards, rather only an evaluation of the current state of affairs.

Another limitation is the generation gap between the senior teachers, novice teachers, and students. Almog and Almog (2016) described the post-Sabra generation designated "Generation Y". This is the first generation to be born into a computerized world, affecting their manners of thinking and life style. The digital language is their first language, versus the older generation (Generation X) defined as "digital immigrants", as they acquired the technology over time. The children born to Generation Y are designated "Generation Z" and their features are essentially similar. The definition of this generation can illuminate how smart boards are accepted in the schools by senior teachers (Generation X) who were technically challenged in accepting the technological change, the

young teachers (Generation Y) who were capable of dealing with smart boards and could use them properly, and the students (Generation Z) for whom it came naturally, as they were born into the digital world and thus their appreciation cannot be perceived as a significant touchstone. This generation was born into a technologically developed world, and a change such as smart boards, which to many seems far-reaching, appears to the young generation a natural and integral part of daily life.

4.2 Benefits of the Study

The research subject is a rich topic with extensive research literature that takes the researcher to many regions of knowledge and varied and interesting issues. Another benefit is the focus on two schools from the same city, in the same ages and from the same religious background. This relative homogeneity facilitated a clearer evaluation of the students' satisfaction with the change implemented by introduction of smart boards, without being confounded by additional interfering variables.

This study might contribute significantly to key figures in the school system in general and to teachers who use smart boards to teach in particular, as the study presents the various areas in which students feel an improvement and those in which the improvement is less conspicuous. The findings can contribute to helping the change lead to greater improvement in all areas investigated in our study.

Further research suggested is to sample high school students who studied with a regular whiteboard in the past and now use a smart board, and thus compare the different board-based study methods. Such a study will enable key figures in the school system in general, and teachers in particular, to see the cost and benefit of the change that occurred with the introduction of smart boards, unlike our study which offers only an evaluation.

In conclusion, we would like to note that we learned a lot about the change that occurred with the introduction of technology and of smart boards to the school system. We were given the opportunity to enter schools that use smart boards, to see the work that is being done from up close, and thus to increase awareness of the change that is taking place.

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