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Doctoral Colloquium—Student Attitudes Toward the Use of the Lightboard Technology in Immersive Educational Settings

Eftychia Aslanidou[1,2], and Georgios P. Heliades[1]

[1]Ionian University, Argostoli, Greece
[2]The Hellenic American NPO, Zakynthos, Greece
easlanidou@ionio.gr
heliades@ionio.gr

Abstract. The Lightboard (LB) is a relatively new educational tool featuring a transparent, illuminated glass surface on which instructors write while maintaining direct visual contact with students. This setup could complement and create a more immersive learning environment, as it allows students to simultaneously observe both the teacher's explanations and the material being presented, fostering a more interactive and engaging experience. In previous studies conducted primarily in the USA, the LB has been shown to enhance cognitive development and sustain student engagement by promoting a more dynamic learning process. This study is the first in the Greek educational context to compare student attitudes toward LB and traditional whiteboards in face-to-face classrooms. The study involved 30 elementary school students from a non-profit organization, and focused on their experiences during math instruction. A mixed-methods approach was employed, utilizing: (a) a Likert scale adapted for the age group to measure students' views, (b) standardized open-ended interviews to explore their perspectives, and (c) teacher observations to capture non-verbal cues and behavioral responses. The results revealed that students using the LB displayed a greater interest and attitude toward learning compared to those using a traditional whiteboard. This suggests that the LB could be integrated into immersive setups and could positively influence student participation in the classroom.

Keywords: Lightboard, Immersive Learning, Student Attitudes Towards New Technologies, Technology Enhanced Learning.

1 Introduction

Post-COVID-19 education demands innovative integration of technology to enhance instructional delivery and engage students effectively [1]. Traditional tools, such as the whiteboard, remain widely used due to their simplicity in presenting and explaining fundamental concepts. However, whiteboards present limitations in large-scale settings, such as auditoriums, where visibility and interaction are restricted by physical constraints [2]. Modern teaching methodologies, including blended learning, combine live and distance education techniques to address challenges, offering a more interactive approach to learning [3]. Instructors are increasingly seeking new technological tools to maintain student engagement amidst an abundance of digital information. One promising solution is the Lightboard (LB), which allows teachers to write while facing students, improving real-time interaction and learning.

Moreover, immersive learning is critical for developing the "4Cs"; Critical thinking, Communication, Collaboration, and Creativity, skills necessary for 21st-century learners [4]. In this context, the LB fosters student engagement while supporting cognitive, metacognitive, and social skill development. For teachers, integrating immersive tools like the LB helps them model creativity and adaptability, essential traits for both students and educators in the modern educational landscape. When teachers use advanced educational tools, they set an example of innovation, demonstrating to students that learning is an evolving process that requires adaptability. In the present study, a new technological and educational tool for Greece, the LB, is explored. While LBs have been developed by researchers across multiple institutions, particularly in the United States, their potential for enhancing student participation and learning in immersive educational settings remains significant. This research

contributes to the broader exploration of LB technology's role in fostering active, immersive learning, and its capacity to reshape the educational experience for students and educators alike.

2 Background to study

2.1 Framing Lightboard

The LB technology was first developed by Professor Michael Peshkin at Northwestern University and Matt Anderson at San Diego State University (SDSU), designed to enhance face-to-face teaching by allowing instructors to maintain eye contact with students while writing on a transparent, illuminated surface [5]. The LB features an LED-lit glass panel where instructors write, with a camera reversing the image for correct orientation. This setup allows students to directly observe the teaching process and engage with the instructor without the common barrier of traditional writing tools. The LB is not only effective in live classroom settings but is also widely used for creating instructional videos, enabling flexible learning experiences (see Fig. 1).

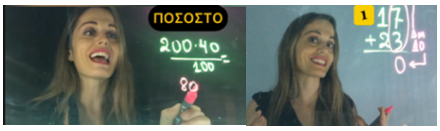

Fig. 1. Instructional Videos using the LB.

In addition, a LB allows the teacher to use a full range of communication methods and visual cues to clarify ambiguous or subtle concepts and promotes students' participation in the learning process. As a result, the biggest advantage of this tool is that the instructor's is not turned away from the audience. The teacher maintains an immediate and continuous presence [5]. In Greece, the students of The Hellenic American NPO Organization have eye contact with the rest of the students when they solve exercises on the LB (see Fig. 2).

Fig. 2. The LB in the The Hellenic American NPO [6].

Fung [7] supports that a LB could replace current lecture videos based on PowerPoint, whose duration often exceeds the average attention span. However, this claim has not been proven through generalizable research, even though it is worth studying by other researchers [8]. Misirlis & Munawar [9] added that the use of a new hybrid environment is more than a necessity for schools. For all these reasons, the benefits of new educational tools deserve to be studied, especially at a time when teachers have to follow new methods and find modern educational tools to use in order to make their teaching more interesting [10]. The LB could help transform traditional passive lessons into active ones by increasing instructor immediacy and facilitating communication.

2.2 Students' Attitudes Toward the Use of Lightboard

Firouzian, Rasmusssen & Anderson [5] created two introductory classes, at SDSU. The 542 students were divided into two groups. The participants of the first group were 215 students who used the LB while being taught and in the second group there were 327 students who used a projector during their lesson. The results of the survey showed that the students preferred the integration of LB technology in the classroom. It provided an opportunity for participants to achieve the same level of learning outcomes as the students in a typical face-to-face classroom. While learning gains remained comparable, instructor immediacy was significantly higher in LB classrooms. In addition, at Western Michigan University a LB was used as a tool to present, clarify and deepen the concepts taught to students [11]. Georgia Southern University used this tool as well to create videos with the flipped classroom model. The students were divided into control and experimental groups. The control groups did not

watch the videos created using the LB. The experimental group, however, used the LB to teach the same unit of the lesson. The Likert scale showed strong and positive support of the LB videos on the understanding, engagement and satisfaction of the research subjects. Specifically, the academic performance of the experimental group increased and their positive attitude toward understanding new concepts influenced [12]. Similarly, Fung [7] pointed out that students' response to the use of LB in education was positive. At Northwestern University, in fact, students used a LB to record their final presentations [13]. Additionally, at Bond University, students showed higher engagement and a more positive perception of the instructor who taught using the LB, and the active learning environment was rekindled [14]. Students provided positive feedback, demonstrating a 17.87% improvement in academic performance and sustained engagement. Finally, at Cornell University, Skibinski DeBennedetti, Ortoll-Bloch & Hines [2] conducted a survey of 500 college students. The participants' opinions were only affirmative and the researchers found that the LB is feasible to manufacture and easy to use. These studies collectively indicate that the LB enhances student engagement, instructor immediacy, and academic performance, making it an effective tool in immersive and interactive learning environments.

3 Research Design

3.1 Aims of study

The present study aims to capture the perceptions of Primary Education students, regarding the use of the LB in a non-formal teaching environment, in relation to a class where a whiteboard only is used. The hypotheses are:

1. Students show more interest towards the LB than the whiteboard.
2. Students have a more positive perception of the LB compared to the whiteboard.

Interest in this study refers to participants' attention, curiosity, and motivation in exploring the two tools, encompassing engagement and enthusiasm. Additionally, perception refers to how students evaluate the tools, including satisfaction and opinions. Collectively, these constructs provide a thorough understanding of participants' interactions with the tools [15].

3.2 Materials and Method

The one key fact of this research is that it is essentially the first relevant research in the Greek area, so the initial understanding of the entire educational environment of the LB is sought. The second point is that the target audience in this phase is primary school students, as the initial choice in a series of studies examining the application of relevant technologies at various educational levels. This targeting led to a mixed sampling procedure. Convenience sampling facilitated access, but final selection followed a structured approach. Specifically, the special characteristics that appear in the sample are Primary school students with homogeneous characteristics, typical development, without cognitive gaps in Mathematics. Their common characteristic is that they are members of The Hellenic American NPO, where they are provided with additional evening training, according to American standards. Also, they come from Zakynthos and have a similar socio-economic situation. The study included 12 boys and 18 girls, randomly assigned to experimental and control groups. Consequently, it was possible to combine quantitative and qualitative research and use analytical and inferential statistics, focusing on specific groups of research participants [16].

This study's methodology was designed using established research protocols, tailored to align with the participants' learning environment and objectives [17]. Quantitative analysis used t-tests, while qualitative data were gathered via structured interviews and observations to capture nuanced student perceptions [18]. Interviews were transcribed, coded, and validated through inter-rater checks. This dual approach addresses criticisms of relying solely on qualitative methods, enhancing the reliability and validity of the findings through triangulation [19]. The combination of qualitative and statistical analysis allows a deeper and comprehensive understanding of the data [18]. Thus, the present research follows the mixed methodology. Each group participated in a 45-minute mathematics class led by the same teacher, who is also the researcher authoring this article. The control and experimental groups were taught identical topics tailored to their respective grade levels, such as the multiplication table of 6 for the 2nd grade, fraction equivalence and simplification for the 5th grade, units and tens for the 1st grade, decimal number decomposition for the 3rd grade, and calculating the area of triangles for the 6th grade. This consistency in instruction ensured that variations in learning outcomes could be attributed to the experimental conditions rather than differences in teaching style. The questionnaires and interviews administered during

evening classes by researchers to The Hellenic American NPO in May 2024. Data confidentiality followed GDPR (EU 2016/679) and Ionian University ethics approval [20].

3.3 Research Instruments

Concepts related to the study of social phenomena cannot be easily measured. Attitude measurement scales provide the possibility of creating general indicators from individual indicators. The Colorado Learning Attitudes about Science Survey (CLASS) scale [21] served as a reference for developing statements tailored to this study. While CLASS assesses attitudes toward science learning, its structure was adapted to evaluate students' attitudes toward their teacher and instructional tools, ensuring methodological grounding while addressing the study's specific context, which further supports its appropriateness for capturing the intended construct. Moreover, this scale is similar to the scale of Duda & Nicholls [22], which was translated from English into Greek by Papaioannou, Milosis, Kosmidou & Tsigilis [23]. The research teams implemented the TRAPD procedures for translation, following the guidelines set by the European Social Survey [24]. These procedures included two independent translations, a review for translation quality by a translator, and input from other educators to ensure statements' age-appropriateness and readability by the students. The opinion survey using a Likert scale also followed the guidelines of Spooren, Mortelmans & Denekens [25—26]. Research subjects were asked to indicate their degree of agreement or disagreement with each statement [16]. It was distributed to the children on a paper. T-tests were employed to compare mean scores between the experimental and control groups, revealing statistically significant differences in student engagement. Furthermore, a semi-structured interview was also used. The interviews enabled the research subjects to express the way they approach various situations through their personal lens. The interview's questions were open and related to the children's opinion towards the two tools and as well the suggestions for improvement. They were based on Genesi's research [27]. Each interview lasted 5-10 minutes. Its aim was to supplement the research data and to obtain as much information as possible about the subjects' views. The interviews were conducted at the end of each intervention in the same room where they were taught. They were videotaped, to make the observation and transcription more accurate. The dimensions to be measured were determined as precisely as possible and the inseparable relationship of the teacher with the context in which it is done was ensured [28]. Also, the language of the tools was in the native language of the research subjects and the instructions were simple and clear. The strong correlations observed among these data sources provide evidence for the concurrent validity of the measure.

4 Data analysis

One of the key items assessed was students' perception of the tool's interest level ('The tool my teacher used was interesting'). Results showed a statistically significant difference ($df = 28$, $t = 2.824$, $p < 0.05$). The experimental group ($M = 5$) rated the LB significantly higher in engagement than the control group ($M = 4.533$), confirming the LB's effectiveness in maintaining student interest. The t-value (2.824) exceeded the critical one-sided t (0.00), with a p-value of 0.00, well below the 5% significance threshold. For the second question ('The tool my teacher used is very useful, especially for learning mathematics'), the experimental group scored slightly higher ($M = 5$) than the control group ($M = 4.666$). The analysis ($df = 28$, $t = 1.783$, $p < 0.05$) also indicated statistical significance, suggesting that students using the LB found it particularly useful for teaching mathematics. Qualitative findings corroborated these results: five students found lessons more engaging, six highlighted consistent eye contact, and two valued the instructor's active presence. In contrast, control group feedback included one child reporting the teacher facing away, three finding the teacher helpful and understandable, and two suggesting that incorporating more colors would enhance the teaching.

5 Results and Discussion

Students demonstrated a stronger preference for LB technology over traditional whiteboards, reporting increased motivation, satisfaction, and engagement. These findings align with previous studies confirming LB's role in enhancing teacher immediacy and creating dynamic learning environments [5, 14]. LB improves clarity and interaction by allowing teachers to maintain eye contact, unlike whiteboards that require turning away. This aspect of teacher immediacy is a significant improvement highlighted in both this research's findings and prior research [13]. Studies suggest that maintaining direct visual contact through tools like the LB increases enhances instructor presence, boosting student satisfaction and learning outcomes. [5, 29]. This aligns with work by Cleto, Miguel, Santos & Vairinhos [30], who found that technologies enhancing visual interaction significantly improve student

focus and participation. This observation is also consistent with findings by Rogers and Botnaru [12] and San's scientific partners [31], who noted similar improvements in student engagement, understanding, and academic performance when interactive technologies are integrated into the classroom. Furthermore, the LB's ability to create a dynamic learning environment by allowing real-time interaction enhances cognitive engagement, a finding echoed by Rossi, Dinorá de Lima, Sabatke, Nunes, Ramirez & Ramirez [32], who reported that active learning tools, significantly improve the learning outcomes, scientific attitude and critical thinking. This study uniquely examines LB use among Greek elementary students, an underexplored area. Previous studies have primarily targeted higher education environments [8], but this study demonstrates that younger students also could benefit from LB technology, particularly in maintaining attention and enhancing learning dynamics. This indicates that LB's effectiveness is not limited to older students or specific subjects, but can be valuable across diverse educational levels and settings [2, 33]. Despite the advantages of the LB, the study also acknowledges the continued relevance of traditional tools like the whiteboard, particularly in their simplicity and effectiveness in presenting information. Overall satisfaction and engagement were consistently higher with the LB, highlighting its potential to modernize teaching methods. This supports arguments made by McCorkle and Whitener [34] who pointed out that LB technology enhances instructional delivery and transforms traditional classroom dynamics into more active and student-centered environments. Studies have shown that the interactive nature of LB technology makes it particularly effective for visual and auditory learners, as noted by Beauchamp and Kennewell [35].

Future research should build on these findings by exploring the cognitive impacts of LB technology, particularly on retention, comprehension, and critical thinking skills [6, 36]. Expanding the study to include a more diverse sample and different educational settings will help validate these results further. Comparative studies with other emerging educational technologies interactive digital boards, could provide valuable insights into optimizing technology integration in modern classrooms [9, 37]. Immersive technologies provide innovative opportunities for engaging learning by leveraging real-world scenarios and simulations. These technologies create practical situations that help learners better prepare for real-world challenges [38]. Especially the new Smart-Lightboard ™ [39] uses a unique technology providing a digital 'layer' over the glass board allowing the user to write digitally, display and interact with images, and it could represent an innovative step forward in modern educational tools. In the context of rapid technological advancements like holographic displays, even cutting-edge tools like the Smart-Lightboard ™ should be seen as part of a broader shift towards more dynamic, hybrid teaching methods. The aim is to create culturally immersive learning experiences for the global citizens [40]. The theoretical foundation is grounded in cognitive load theory, which posits that reducing extraneous cognitive demands improves learning efficiency [41]. Imagine combining a LB with holograms, allowing students not only to see their instructors but also to interact with 3D models and visualizations in real-time. Also, by integrating LB with Virtual Reality (VR), an instructor could simultaneously demonstrate a concept on the LB while students explore a related virtual environment, allowing them to apply the information in a simulated real-world context.

6 Conclusion

This research provides new evidence of the positive impact of LB technology on student engagement, satisfaction, and motivation compared to the traditional whiteboard. LB users expressed greater interest and found it more engaging than conventional methods. These findings contribute to the growing body of research supporting the use of innovative educational technologies to enhance teaching and learning experiences [5, 14]. The study's unique focus on elementary students in Greece adds a new dimension to the existing literature, which has predominantly concentrated on higher education settings [5, 13]. This demonstrates that the benefits of LB technology are applicable across various educational levels, making it a versatile tool for fostering positive student attitudes and improving instructional immediacy. The ability of LB technology to keep students engaged aligns with findings by Maričić & Lavicza [29], emphasizing the need for visual tools that support active participation and sustained attention. Future studies should broaden sample diversity and examine LB's cognitive impact relative to traditional tools [7]. Despite the strengths of this research, several other limitations must be acknowledged. Although efforts were made to ensure internal validity through random assignment and consistent data collection procedures, the reliance on self-reported measures could introduce response biases. Understanding the nuances of teacher-student dynamics in different settings will further illuminate the potential of LB technology to revolutionize modern education [11, 31].

This study reaffirms LB's role in modern education, particularly in enhancing engagement among younger students, where engagement and interaction are crucial for learning success [33]. By integrating immersive technological tools like the LB, educators can create learning environments that not only engage students, but also prepare them for real-world challenges through practical applications and simulations. However, much like other

immersive tools, LB technology faces challenges related to affordability, content creation, and accessibility. Furthermore, LB technology shows significant potential in modern education, aligning it with the broader trend of using immersive technologies to foster deeper learning and improved long-term retention. The LB's ability to simulate face-to-face instruction while maintaining real-time interaction can help on creating an immersive learning environment where students are active participants in the educational process. Future research should focus on longitudinal outcomes and explore integration strategies with other immersive. The focus of the analysis on LB should not be primarily on the tool itself, but rather on the theoretical framework supporting the use of hybrid teaching methods and technologies to engage today's learners. In an age where students are increasingly exposed to advanced digital tools and immersive technologies, traditional methods of instruction may struggle to capture and sustain their attention. From its introduction, LB's effectiveness lies not in the device itself, but in how it fits within a broader, more adaptive system of teaching that moves away from static, instructor-centered methods toward more interactive, dynamic forms of engagement. It is essential for future research to investigate the unique qualities of a LB that effectively incentivize students to attend class. More broadly, studies should explore how educational tools and methods can remain compelling in a world where digital devices surpass traditional educational frameworks in terms of technological advancement and engagement. The challenge is in recognizing and adapting to the shifting landscape of education, driven by the needs and expectations of a generation raised in a hyper-connected world.

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