

Configuration and Use of Lightboard System in Online Environment: Lessons Learned During COVID 19 Pandemic

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Abstract

Teaching and learning environments include two basic modes – face-to-face and online environments. It is a known fact that most students prefer a face-to-face environment to an online environment for one main reason – engagement. Within the context of learning, engagement relates to how well students’ senses are engaged and stimulated for learning. The design of course delivery and instructional technologies aim to engage students for effective learning. Teaching online has its advantages, but it also falls short of effective student engagements. Due to the COVID 19 pandemic, educators were forced to teach online and to find creative ways to deliver the courses in an engaging format. One of those course delivery and instructional technology is the use of the lightboard (glass board) system. Lightboard is a writing board with clear glass as the writing surface and special neon markers for writing. The instructor faces the camera/students when he/she writes, and the writing on the board glows from the light beam on the glass. Lightboard is set up in a low-light space with only the focus light directed at the glass board and the instructor writing on the glass board. In addition, a dark drop cloth hug behind the instructor is used to enhance the background and help to make the writing on the glass board crisp and clear. Lightboard setup allows instructors to write, diagram, illustrate, gesture, demonstrate, or explain a formula without blocking the board with their body and without turning their back to the camera/students. Because the writing on the glass board is backward in the direct view of a recording camera, the writing must be flipped in the video streaming system, and what the students see in real-time is a horizontally flipped video streaming from the online video-conferencing application. In this research, lightboard system as a tool is evaluated from the point of student engagement and the ability to reduce the transactional distance that may exist between the students and the instructors. This research follows a qualitative research method. The research examined the design, configuration, setup, and use of lightboard system for teaching synchronous online courses from home during the COVID 19 pandemic. The research evaluated students’ perception of lightboard system as an effective course delivery and instructional technology. The research findings indicate that there are a few easy to find, affordable components, and open-source video recording and live streaming software that can be configured to create a lightboard system. The research findings also show that majority of the students found the use of the lightboard system as engaging. The research strongly recommends the use of lightboard system for online course lectures requiring drawing details, writing formulas, showing step-by-step computations on the board. In addition, the research recommends lightboard system for flipped classroom in cases where video capture of lectures entail diagrams, formulas, and computations.

Literature Review

This research has two objectives. The first is to present how to design, configure, and build a lightboard system for synchronous online teaching from home during the COVID 19 pandemic. The second objective of the research is to evaluate students' perspectives on the use of lightboard as instructional technology.

Body language, gesture, facial expression, voice, and tempo are all important in teaching, all of which help to focus students' attention and help to engage them. In education, student engagement refers to the degree of attention, curiosity, interest, optimism, and passion that students show when they are learning or being taught. Engaging students in the classroom requires some gestures (motions, actions, movements, nods, etc.) – positioning of the body, facial expressions, hand movements, drawing on the board, writing equations on the board, and solving problems on the board. In a typical face-to-face classroom, using gestures to engage students is easy. However, in a synchronous online environment, it is not that easy, except where the full-body frame of the instructor is captured. The design of course delivery and instructional technologies aim to engage students for effective learning. Such design is highly needed in an online environment. In an online environment, instructional technology should be designed with student engagement in mind.

In a face-to-face environment, there is a connection between the students and the instructor, or the students and the content. However, in an online environment, the connection is not so obvious. Moore and Kearsley [1], explained that the separation of instructor and learners creates a psychological and communications space referred to as the transactional distance. Lightboard-enhanced teaching could help close transactional distance that may exist between the students and the instructors in an online environment.

Educators, typically have three basic options for presenting lectures in a face-to-face setting. One option is to write the content on the whiteboard or blackboard, the other option is to present the content on PowerPoint, and the third option is a mix of both. However, some challenges may be encountered when moving from face-to-face to an online environment.

Educators who use PowerPoint presentations in a regular face-to-face classroom may have an easy transition to an online environment – screen share the PowerPoint content. On the other hand, educators who use the whiteboard or the blackboard in a regular face-to-face classroom, will quickly realize that the online environment does not offer better alternatives to the whiteboard or blackboard. What the educators get in an online environment is a digital writing board that shows what the educators are writing without showing the interaction of the writer with the content or the students. In such cases, those instructors wishing to find an alternative to the digital writing board in an online setting will have to be creative in how they go about this, and this is where the lightboard comes in – build a DIY (do-it-yourself) lightboard system.

The different methods or options for delivering synchronous online lectures include:

1. Content presentation with the talking head picture (voice-over) format, with or without the digital writing board

2. Content presentation with the talking-head video (video over) format, with or without the digital writing board
3. Lightboard format - content presentation with the full body video format
4. A mix of the three options above

According to Bettinger and Loeb [2] engagement in the classroom could be argued as the key to why most people prefer face-to-face learning. According to a report on online education especially with least prepared students, the research argues that the major difference between virtual learning and face-to-face courses is the level of student-instructor interaction, which can negatively affect student performance in online learning. A recent study by Elumalai et al [3] surveyed 784 undergraduate students from higher education institutions in India and the Kingdom of Saudi Arabia and found that seven factors that positively affect the quality of virtual learning include: administrative support, course content, course design, instructor characteristics, learner characteristics, social support, and technical support.

Being present and staying present in an online learning environment may be difficult as compared to a face-to-face learning environment. We all know too well about being physically present, but mentally “checked out.” This situation could be made worst in an online environment with so many distractions, making it difficult for students to focus. Additionally, a student’s learning preferences may have much to do with their learning styles. As noted by Chick [4], students learn differently, and there are three main learning style categories: visual, auditory, and kinesthetic. Visual learners are those who prefer written material and instructions, diagrams, posters, and demonstrations. The auditory learners learn best when there are oral components to the material being learned. Kinesthetic learners learn best when they can touch and feel what they are learning about. The use of lightboard in online teaching may provide an interactive and engaging experience for most learning styles.

Lightboard and Application of Lightboard in Teaching and Learning

Lightboard is a writing board with clear glass as the writing surface and special neon markers for writing. The instructor faces the camera/students when he or she writes, and the writing on the board glows from the light beam on the glass. Lightboard is set up in a low-light space with only the focus light directed at the glass board and the instructor writing on the glass board. In addition, a dark drop cloth hug behind the instructor is used to enhance the background and help to bring the writing crisp and clear. Lightboard setup allows instructors to write, diagram, illustrate, gesture, demonstrate, or explain a formula without blocking the board with their body and without turning their backs to the camera/students. Because the writing on the glass board is backward in the direct view of a recording camera, the writing must be flipped in the video recording system, and what the students see in real-time is a horizontally flipped video recording from the camera.

Michael A. Peshkin, Professor of Mechanical Engineering at Northwestern University, is credited with developing the first lightboard in a higher education setting [5]. Professor Peshkin developed the lightboard in 2013 to help with flipped or blended learning on lectures that required drawings and equations. Since then, several variations of lightboard have been in use.

Some universities have lightboard studios where educators can record lecture presentation videos. The use of lightboard for flipped classrooms is well-documented. Fung [6] documented how lightboard system was used for teaching chemistry using the flipped-classroom format. The author showed lightboard as a better alternative to the use of digital writing board or the use of screencasting of PowerPoint presentation for flipped classroom format. Fung argued that for flipped classroom design, the use of the lightboard format allows for engaging, concise, and bite-sized videos with little or no postproduction required. While lightboard can be used for flipped or blended learning, it can also be set up for synchronous online teaching with real-time broadcasting. However, a DIY lightboard system can be challenging due to various issues such as sourcing of components, time to put them together, and the cost of building one. A recent investigation by Corkish [7] found that the price of a DIY lightboard system range from \$2190 for a 3.7' x 2' size to \$7,000 for a 5.7' x 2.7' size. Rosasco [8] found that the use of lightboard could provide for some human interaction in online teaching. The paper explained that for teaching online using video conferencing applications, the use of lightboard system was found effective for bridging the gap between the students and the instructor. The research showed that the use of lightboard offers a depth of connection and presence of the instructor. The research by Rogers and Botnaru [9] on the use of lightboard videos to enhance learning, showed strong improvements in student learning with the use of lightboard videos. This result also contained positive comments from the students about the use of lightboard.

Research Methodology

There are two parts to the research method. The first part is the configuration and setup of the lightboard system, and the second part is students' perception of the use of lightboard system in teaching.

The author chose to use lightboard system combined with the presentation of other content necessary to teach a synchronous online course. This means that the content can be cast on the screen at the same time for students to see. For example, while students can see the instructor writing, drawing, doing computation on the lightboard, they can also see a PDF drawing being referenced in the lecture, or a PowerPoint presentation cast on the screen to reinforce the topic of the day. This requires a second monitor with the option for multiple displays of different content on the screen to be shared with the students.

The Configuration and Setup of the Lightboard System

Following the chosen design for delivering a synchronous online course, various components were put together and configured to create the lightboard system. The lightboard system is made up of the glassboard which is the writing surface, the glassboard frame which holds the glassboard, the overhead light which illuminates both the glassboard and the instructor. There are sidelights that illuminate the glassboard and help to make the writing on the glassboard come alive. In addition, the neon markers are the writing pen of choice because they glow with the light beamed on them. Other important components of the lightboard system include the black drop cloth, the black window blind to help reduce outside light from reflecting on the glassboard. The system also requires the use of the computer camera to capture the video or the use of an

external camera such as a phone camera or an iPad camera. If using an external camera, a tripod may be required to set up the camera. Since the speaker is a few feet away from the computer, there may be a need to capture audio using a mic if the instructor's voice does not project loud enough to be picked up by the laptop. When using an external camera, a piece of software is required to let the computer know to use the external camera. Finally, a piece of broadcasting software will be required to record the video capture of the instructor on the lightboard. Figure 1 shows some of the parts of the lightboard system and the layout of the home office used for synchronous online teaching.



Figure 1. The home office/lecture room configuration and setup

Figures 2 and 3 as shown below provide a view of what the students see when the second monitor screen is shared with the students.

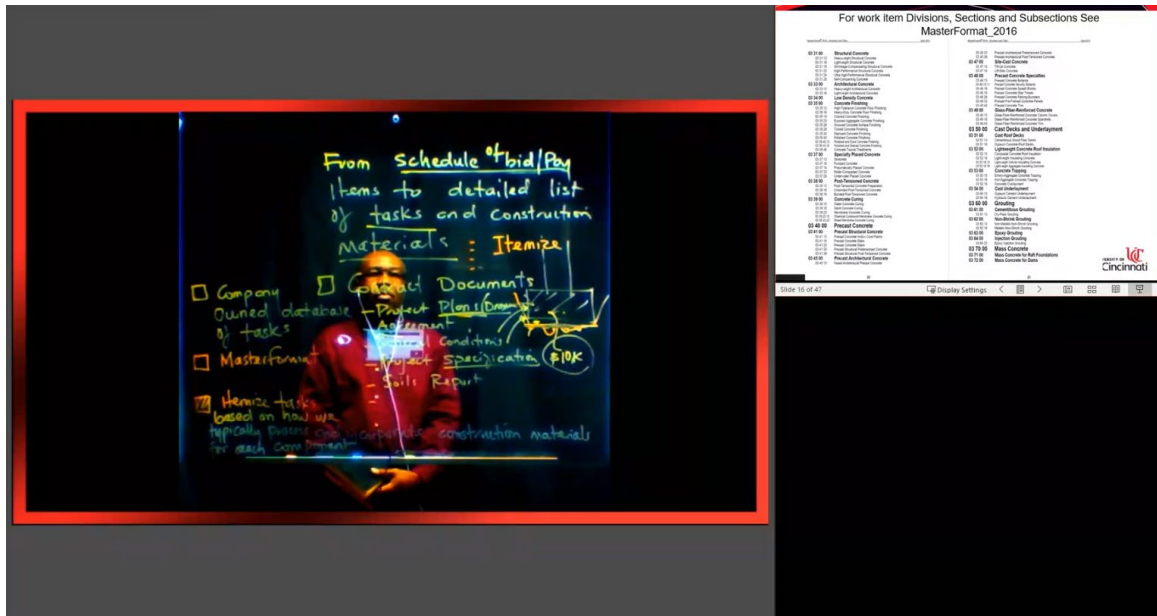


Figure 2. The capture of screen share with the lightboard system in recording and PowerPoint presentation on the side

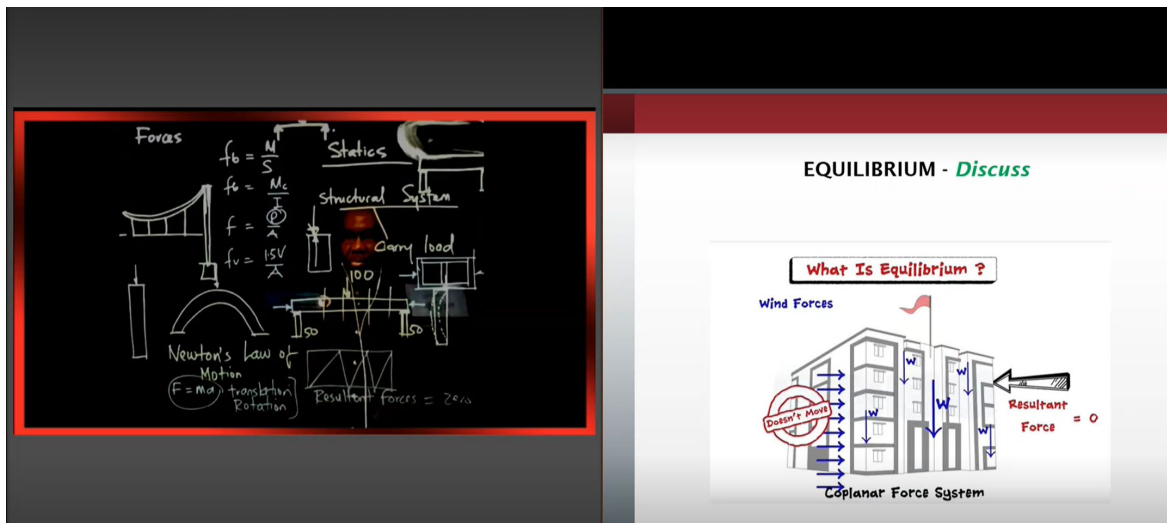


Figure 3. The capture of screen share with the lightboard system in recording and PowerPoint presentation on the side

Students' Perception on the Use of Lightboard System in Teaching

One of the research objectives was to gather students' perspectives on the use of lightboard. The survey participants included students enrolled in six of the courses taught by the author in 2021 academic year where the author used the lightboard systems. The six courses included 1) CM2001 - Construction Documents, Law, & Project Delivery Systems, 2) CM3003 - Construction Materials and Supervision, 3) CM3034 - Cost Estimating and Costing, 4) CM3035 - Project Planning, Scheduling, and Control, 5) CVE5104/CVE6004 - Temporary Structures, and 6) CVE5145/CVE6045 - Heavy Highway Estimating. The survey was designed to better

understand student experiences and measure how students perceived the use of lightboard in the lectures. After the survey collection ended, the responses were analyzed thoroughly. In addition to the basic descriptive statistics, several commonly repeated themes emerged.

The questions that were posed to the students are shown below. The first is a Likert scale question and the second is an open-ended question.

1. About the lightboard enhanced method, on a scale of 1 to 3 how well did this teaching format make you feel as though the live online lecture was like a face-to-face in-class lecture? Select one.

- 1 - Not Much
- 2 - Fairly Well
- 3 - Very Well

2. Feel free to provide comments and suggestions if you wish to

Research Findings and Discussion

The chart below in figure 4 captures the research findings on how well the use of lightboard enhanced and engaged students' learning when compared to face-to-face learning. The chart below shows that more than 70 percent of the students from each course are of the opinion that the use of lightboard feels as though it was like face-to-face in-class experience.

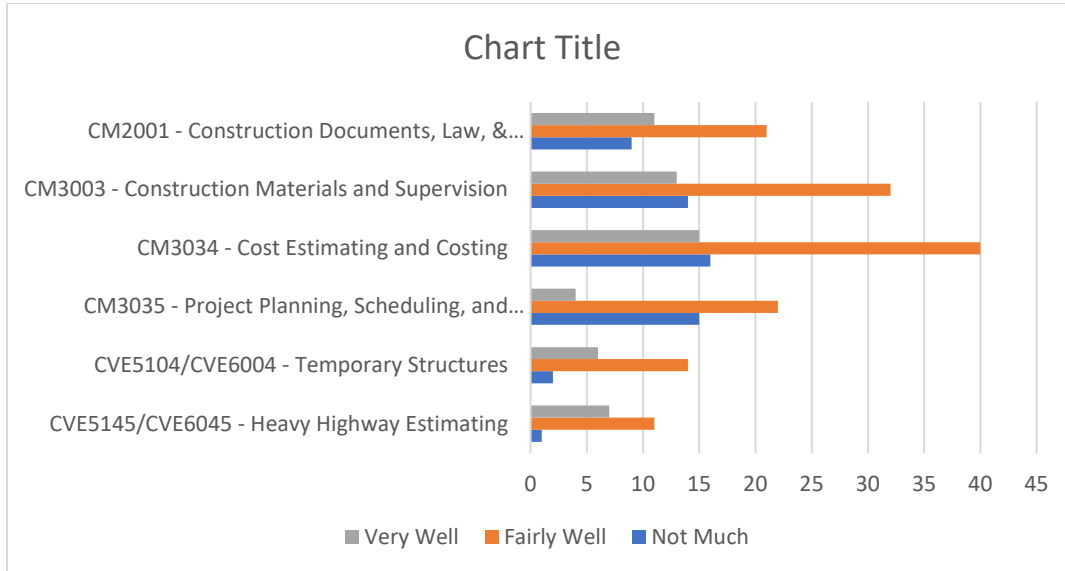


Figure 4. A chart showing how well the lightboard system enhanced and engaged students' learning

Several informative themes emerged from comments provided by the students. The comments are broken into two groups.

The first group of comments focuses on the quality of the lightboard system. All the comments from the students were constructive and a good number of them pointed out that the glassboard was hard to read sometimes because of:

- a. light glare and reflection of light on the glassboard covers what is written or drawing on the board,
- b. the color of the notes would blend too much with the light on the board.
- c. notes are tiny to read, sometimes when the board gets crowded after going over multiple topics it gets hard to read. Writing slightly larger would help.
- d. the monitor screen area of the lightboard video is not large enough. If you could, make the light board full screen if you are not using the PowerPoint for class. The window needs to be more zoomed in.
- e. standing directly in front of the glassboard and not wearing a dark shirt makes it difficult to read what is written on the board
- f. computer screen used to record causes a glare on the board that sometimes makes it hard to read what is written
- g. logo on a shirt blending with the writing

The above comments from the students were implemented for an enhanced lightboard system that is glare-free, reflection-free.

In addition to the issue about the glassboard being hard to read sometimes due to glares and reflections on the glassboard, this second group of comments provides a summary of students' view about their learning experience and perception of the use of lightboard. The key themes from students' responses to the open-ended question are presented below under table 3

Table 3. Students' View About the Use of Lightboard System

The use of lightboard is more interactive.
This is the first time I saw the method used in a virtual classroom,
I like the efforts made to make the virtual class experience better.
The experience makes it feels like almost in-person classroom learning.
I like the idea of using the lightboard to simulate in-class experience,
The lightboard can be difficult to see and read at times,
The lightboard is engaging and helps with or inspires note taking.
This form has been refreshing rather than just flipping through presentation slides.

Additional findings from this research show that even though lightboard was used for live synchronous teaching, it could easily be used for flipped classroom design. In addition, the lightboard system as implemented here does not require any postproduction since this was done in a live setting. Also, the setup does not require additional resources to capture the video since OBS is configured for this. As such, this is a plug-play low resource setup. An important finding is about the cost to build a DIY lightboard system at home.

Cost Estimate of Components for a 4' x 3' Lightboard System

The list below in table 1 captures the price paid to procure the different components that the author used in building a lightboard system used for synchronous online teaching.

Table 1. Price list of components and software used

Items		Price
1	Audio-Visual Direct Glass Dry-Erase Board Mobile Stand (4' x 3') Stand ONLY, Does NOT Include Board	\$160.49
2	Audio-Visual Direct Clear Glass Dry-Erase Board Set - 4' x 3' - Includes Hardware & Marker Tray (Non-Magnetic)	\$105.07
3	2 Units of EMART LED Video Light 11 Brightness/4 Color Filters Dimmable Photography Continuous Tabletop Lighting, Adjustable Tripod Stand, USB Portable Fill Light for Photo Studio Shooting	\$48.50
4	1 Unit of LED Shop Lights for Garage 4 Foot with Plug, Air and Waterproof Linkable LED Tube Light 5000K Under Cabinet Lighting, 3600 LM LED Ceiling and Closet Light 36W, Corded Electric with ON/Off Switch	\$43.11
5	Room Darkening Thermal Insulated Blackout Grommet Window Curtain for Room, Black,42x63-inch,1 Panel	\$10.99
6	5FT x 10 FT Portrait Photography Backdrop Black, Velvet Fabric Screen Non-Reflective Photo Background for Studio Product Shooting Props	\$28.02
7	EpicCam Software for connecting the iPad camera as the source camera	\$7.99
8	Mic for audio - 3.5mm Headphone Extension Cable, Cable Creation 10FT 3.5mm Male to Female TRRS Audio Stereo Cable, Right Angle Auxiliary HiFi Cable with Silver-Plating Copper,24K Gold Plated (Microphone Compatible)	\$18.95
9	57"-inch Pro Series Aluminum Tripod with a Tablet Mount fits iPad, iPad Air, iPad Mini & Most Other Tablets	\$19.39
10	OBS (Open Broadcaster Studio) video recording and live streaming software with feature to transform/flip video horizontally, and to filter/ color correct the video quality – an open-source software	free
	Total	\$442.51

As shown above in table 1, based on the lightboard design chosen by the author, the cost to buy the components of a lightboard system is under \$500, and this should be encouraging for other educators who may be interested in a DIY lightboard system.

Challenges and Recommendations in Building the Lightboard System

Constructing a DIY lightboard system involves trials and errors in order to figure out what works and what does not work. Based on the available room space, an instructor trying to build a lightboard system at home would have to figure out the best fit for all the related and connected components.

For example, the initial plan was to fabricate the glassboard with wood framing and plexiglass, but that plan was abandoned when the author found out that there are off-the-shelf frames and glass that could be procured to fit and assembled at home. The frame and glass size of 4' x 3' was selected due to available room space. The author had considered using the 5' x 3.4' frame and glass size, which would offer more space to write and draw, but there was not enough space in the room.

The author started with just the laptop monitor as the main screen to display and share content with the students and quickly realized that a second monitor is a must, especially if different content would need to be presented to the students at the same time. More so, a monitor with the display manager feature is preferred as it would allow the instructor to compartmentalize different content in one display. A display manager is a feature that allows users to control and change the settings of a monitor to multi-monitor layout, and to also create a custom layout. There are several advantages to a large screen monitor, and in this case, they include larger viewing areas and high definition. The choice of the second monitor should be at least 20”x12” so that the different content on the monitor is seen clearly by students when the instructor shares the screen with them.

The author started using the laptop camera for recording and also quickly found that using the laptop camera was not the best option. For example, the laptop camera does not have a zoom-in or zoom-out feature and requires moving the glassboard around to get in focus. The use of an iPad as a second camera solved this problem.

Getting the right lighting and positioning the lights in the right location was one of the biggest challenges that the author ran into. This resulted in experimenting with different LED garage lamps for the overhead light and the sidelight. Finally, a better fit was found for the overhead LED hay light and LED sidelight that came with an adjustable tripod.

Like the room lighting which resulted in trial and error, finding the right drop cloth background was also a challenge. Through this process, it became obvious that the drop cloth does not only need to be black, but also needed to absorb light, and the black velvet fabric became the drop cloth of choice.

What to wear when presenting is equally important. The author found out that dark clothing such as black color, maroon color, or red color works best. Colors that do not reflect light work best because they will not obscure the writing and drawings on the glassboard while standing behind. Also, it is best to avoid clothing that has bold and visible text on them because the text will be flipped back along with the rest of the content on the glassboard.

Two different software were used in the process. The first is the EpoCam which was used to tell the computer to work with the external camera. The software also has the feature for flipping the image horizontally. The second software is the open-source OBS software. The OBS software has two features that are of use in this context. One is the ability to horizontally flip the image so that students see the writing on the lightboard as left to right writing and not right to left. The second feature in OBS is the color correction feature which is used to improve the background color and help make the video capture stand out and the writing on the board sharp.

Finally, it is important to remember that there is no postproduction in synchronous online course delivery, as there is no time to edit what students see. This means better preparation which is no different from how educators typically prepare before walking into a face-to-face classroom full of students eager to learn.

Conclusion

The design of course delivery and instructional technologies aim to engage students for effective learning. Lightboard system is an instructional technology aimed at enhancing teaching and learning. Specifically, lightboard system aims to bridge the transactional gap between the students and the instructor and to make learning more engaging. In this research, lightboard system as a tool is evaluated from the point of student engagement and the ability to reduce the transactional distance that may exist between the students and the instructors. In addition, the research presented how a DIY lightboard system can be constructed. The research found that there are affordable components, and open-source video recording and live streaming software that can be configured to create a lightboard system. The research also found that majority of the students found the use of the lightboard system as engaging. The research strongly recommends the use of lightboard system for synchronous online course lectures requiring drawing details, writing formulas, showing step-by-step computations on the board. In addition, the research complements other research in the use of lightboard systems for flipped classroom methods.

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