Getting the Classroom Display Right

Understanding the Key Factors Driving Display Visibility and Legibility

EPSON®
EXCEED YOUR VISION

Contents

Over the last 15 years the classroom has changed in dramatic ways, not the least of which is the impact of technology on the education process. From a time where the only way to communicate was verbal or on a blackboard, the integration of computers and large displays is changing the educational process. In this white paper, the key factors that impact the effectiveness of a large display in the classroom will be analyzed in detail to enable the reader to understand key criteria based on industry standards.

While the paper will focus on the display attributes, there will not be a focus on the decision between a passive display and an active, interactive display. It is assumed that the values of the interactive display are well understood by most educators through the extensive research of the last 10 years on the subject. In fact, two of the five use cases of a large display in the classroom use the interactive capabilities.

This paper will focus on understanding the key factors that drive the visibility and legibility of the display and how that impacts the potential learning of the students throughout the classroom. In this paper the required capabilities for a quality visual experience will be described. In today's advanced classrooms, displays are used for a range of educational purposes, often for 50% or more of class time, assuring that the display technology chosen delivers a quality educational experience is critical.

Size and Distance

The two key factors for defining a display in the classroom are the potential size of the display and the distance from which the students are viewing the display. Both of these are defined by the physical attributes of the space; the room height defines the maximum display height/size, while the room width and depth as well as the seating define the viewing distance of the students. The key to delivering an effective educational outcome when deploying these devices, is assuring that all students have an all-around high quality experience.

■ Screen Height

In the next section, the distance from the screen will be discussed based on accepted industry standards. These standards, based on how human visual acuity works as well as traditional eye structures such as the Snelling Eye Chart, generally express acceptable distances in multiples of the display height or vertical measure. Accordingly, understanding the limitations on display height in a typical classroom is an important factor. The first limitation of screen height is the actual ceiling height of the classroom. While some classrooms are as short as the typical 8 foot

residential ceiling height and some are very tall, a reasonable average is about 9 feet. The second limitation is the height of the bottom of the screen off the floor. This is driven by the student's height while seated. While average adults have a seated eye height of between 27.4 and 33.5 inches, students eye height will be dependent on their grade and age. For a typical 6–12 classroom, the shorter adult measurements are reasonable. For purposes of this analysis, a seated eye height of 28 inches will be used. This is 20 inches above the typical 18 inch chair used in most 6–12 classrooms. Figure 1 shows a typical classroom with 6 rows of seating and the unblocked vision line for each student

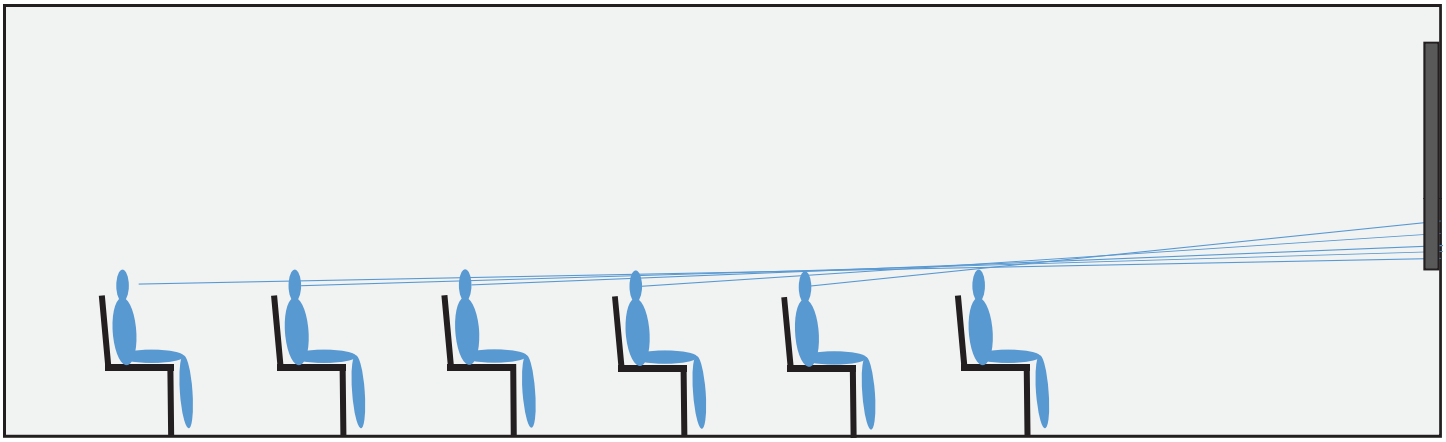


Figure 1 Display Bottom Height

The 4/6/8 Rule

In the AV installation world, there is a common standard for selecting viewing distance from a display based on the rule of 4/6/8. The rule says that for different types of viewing, the viewer can be located at a distance that many times the screen height. Recently, ANSI/InfoComm have documented this rule as an ANSI standard with the Display Image Size for 2D Content in Audiovisual Systems (DISCAS) standard. The DISCAS standard defines 3 types of viewing and the associated maximum multiple of vertical display height:

Analytical Viewing—Maximum 4 Times Vertical Display Height

The viewer can make critical decisions by the ability to analyze details within the displayed image. The viewer is analytical and fully engaged with these details of the content (e.g., architectural/engineering drawings, forensic evidence, medical imaging, and photographic image inspection).

Basic Viewing—Maximum 6 Times Vertical Display Height

The viewer can make basic decisions from the displayed image. The decisions are not dependent on critical details within the image, but there is assimilation and retention of information. The viewer is actively engaged with the content (e.g., information displays, presentations containing detailed images, classrooms, boardrooms multi-purpose rooms, product illustrations).

Passive Viewing—Maximum 8 Times Vertical Display Height

The viewer is able to recognize what the images are on a screen and can separate the text or the main image from the background under typical lighting for the viewing environment. The content does not require assimilation and retention of detail, but the general intent is understood. There is passive engagement with the content (e.g., non-critical or informal viewing of video and data).

The advantage of using the 4/6/8 definitions for classroom is that the distances can be mapped to the activities typically done using the display. The 4/6/8 is a recommended MAXIMUM viewing distance for each activity. The standard recommends that no content be viewed from farther than 8 times the screen height as typical text and fonts as well as objects will not be readily visible to the viewer, resulting in a significant reduction in comprehension.

Typical Classroom Use Cases and 4/6/8 Suggested Viewing Distance

There are five primary use cases for a display (including interaction) in the typical classroom:

- Movie Watching
- Presenting Multimedia Curriculum Materials
- Teacher Whiteboarding
- Student Whiteboarding
- Web Content Browsing

Each of these cases falls into one of the 4/6/8 recommended distances.

Movie Watching

Movies, including those based on education content, are the typical use cases described for Passive Viewing. While a closer distance may be desirable for certain educational content that has significant detail, generally this is a use case that falls into the 8× height maximum viewing distance.

Presenting Multimedia Curriculum Materials

Presenting Multimedia Curriculum is covered very closely in the Basic Viewing parameters. The content is generally sized for a display and the fonts used are sufficiently large to enable viewing at the 6× maximum viewing distance recommended by the standard.

Teacher Whiteboarding

Teacher Whiteboarding is an activity that is very dependent on the individual teacher and their writing style. However, the content and information presented are typically covered by the Basic Viewing parameters, so a 6× maximum viewing distance is recommended.

Student Whiteboarding

Student Whiteboarding is similar to the teacher, however the typical student will be less trained and comfortable and may write with much smaller letters. Again, the Basic Viewing is the most appropriate, recommending a maximum 6× viewing distance.

Web Content Browsing

More and more, accessing the Internet through a web browser is becoming an important teaching and learning tool. The challenge with internet content is that it is generally designed to be viewed on a desktop display of relatively large size and closer viewing distance. Depending on the web page, much smaller fonts may be used than those in a typical presentation. While Basic Viewing can also be applied to web browsing, on some occasions it may approach the Analytical Viewing. However, as will become clearly apparent when classrooms are analyzed, the 6× standard for maximum viewing distance is best to apply here as well.

The conclusion is that for the best overall usage of the display, the maximum viewing distance in a typical classroom should be less than 6 times the screen height.

Comparison of Room Options

It is clear that the limiting factors for a quality classroom experience are driven by two factors, the maximum display height of about 50–55 inches and the need to maintain a maximum viewing distance of less than 6 times the actual selected display height. To better understand how display size impacts viewing distance, three typical classrooms have been analyzed comparing a 65 inch diagonal Flat Panel Display (FPD) display to a 100 inch diagonal wall mount projector. Both meet the maximum height requirement: the 65 inch FPD display height is about 32 inches and the 100 inch projector is about 53 inches. Both systems can include interactive capabilities, so the primary comparison in this paper is on the viewing distance. The three classrooms represent a square, wide, and deep room layout. These are shown in Figure 2. The general size for the classrooms is based on the California recommended classroom size of 960 square feet. All classrooms are populated with 30 chairs/desks (except the wide that has 32 due to the row count). The chairs and desks are based on typical 6–12 sizes and spacing. For each classroom type, the relative viewing distances based on the 4/6/8 rule will be shown. As the analysis shows that the best educational outcomes will occur with all students at less than the 6 times the display height as the maximum viewing distance, that will be the primary consideration. For completeness, the analysis will include both 4× and 8× distance.

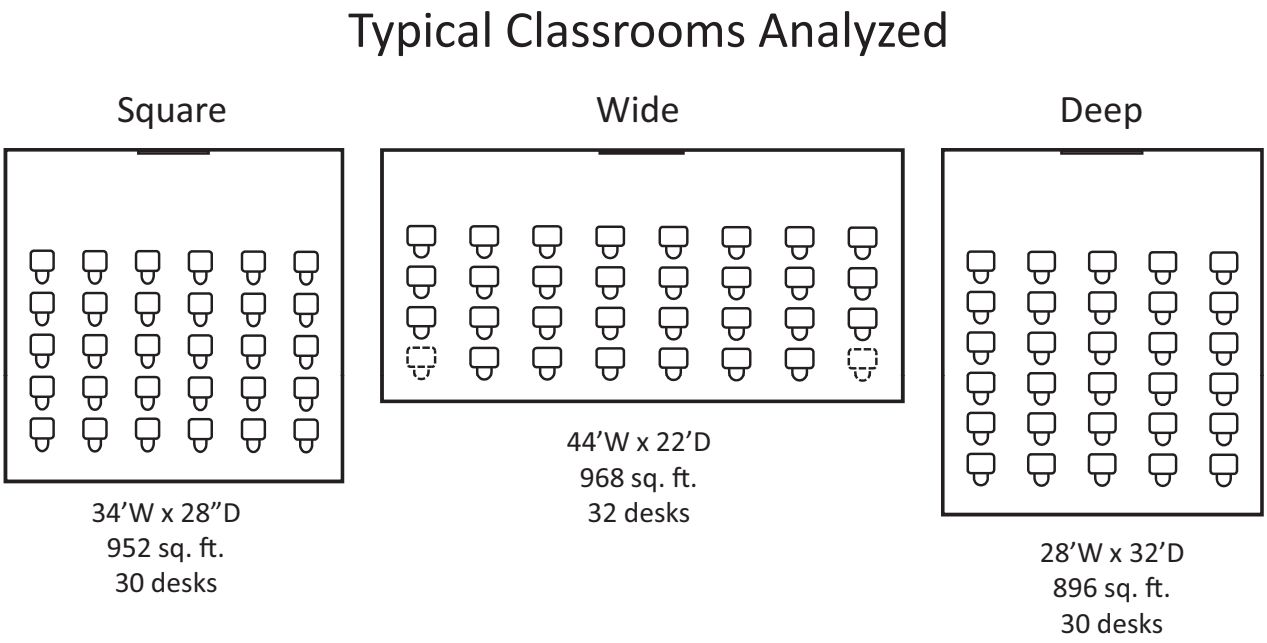


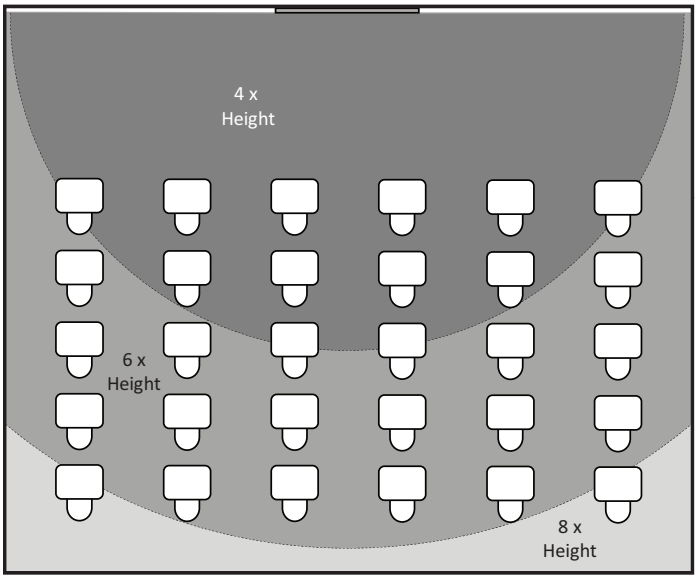
Figure 2 Typical Classroom Shapes

Square Classroom

The square classroom is an approximation of the 960 sq ft recommendation with 30 student seats arranged in a 5 × 6 desk arrangement. Space has been left at the front of the room for the teacher desk and additional items and to provide adequate viewing distance for students in the form row. Figure 3 shows the relative viewing distances for both the 100" projector and 65" FPD.

Typical 952 Square Foot Classroom with 30 Desks (34 feet W x 28 feet D)

Classroom with 100 inch wall mount projector display



Classroom with 65 inch Flat Panel Display

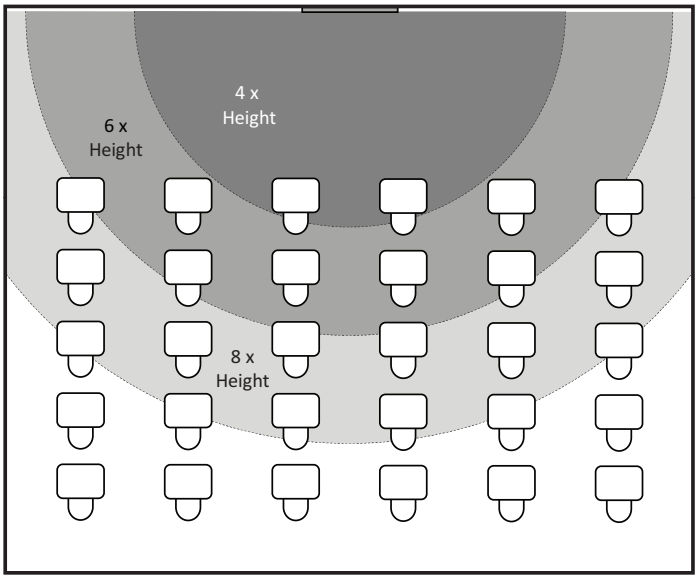


Figure 3 Square Classroom Viewing Distances

As can be seen, with the exception of the back row desks on either side, the 100" projection display provides the optimal 6× viewing distance to 93% of the seats. In fact, with the 100" projector, 27% of the students are within the 4× distance, ideal for those with eye challenges or other issues. The FPD has a much lower level of acceptability. 80% of the students in this classroom will be over the 6× distance and 40% will be beyond the absolute 8× maximum recommendation. Clearly, the size and view ability of this display will have a major impact on the educational outcomes in this room.

■ Wide Classroom

Many newer classrooms have been built with a wider proportion to reduce the distance from the teacher to the student. Figure 4 shows just such a classroom. The number of rows has been reduced to 4, yielding 32 student seats. The back left and right seats are dashed as these should not be considered in the actual comparison.

Typical 968 Square Foot Classroom with 32 Desks (44 feet W x 22 feet D)

Classroom with 100 inch wall mount projector display

Classroom with 65 inch Flat Panel Display

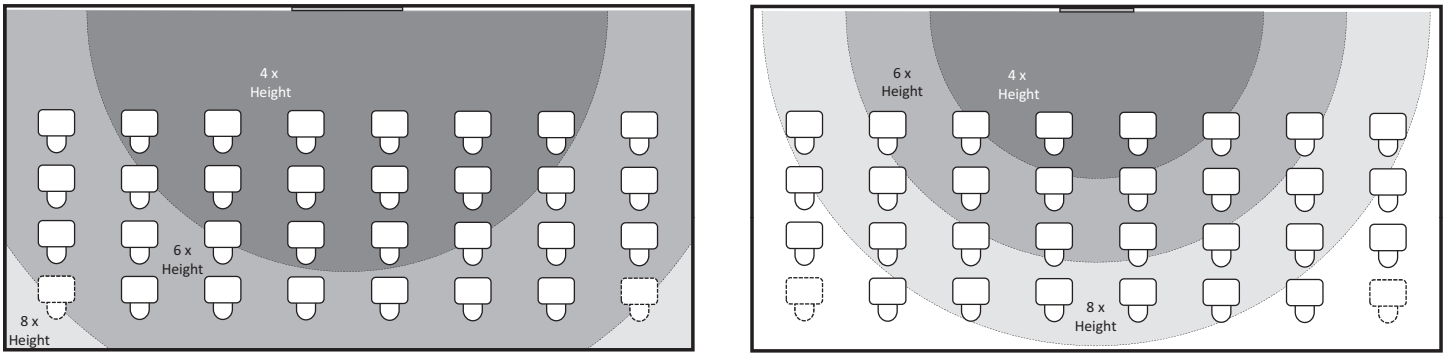


Figure 4 Wide Classroom Viewing Distances

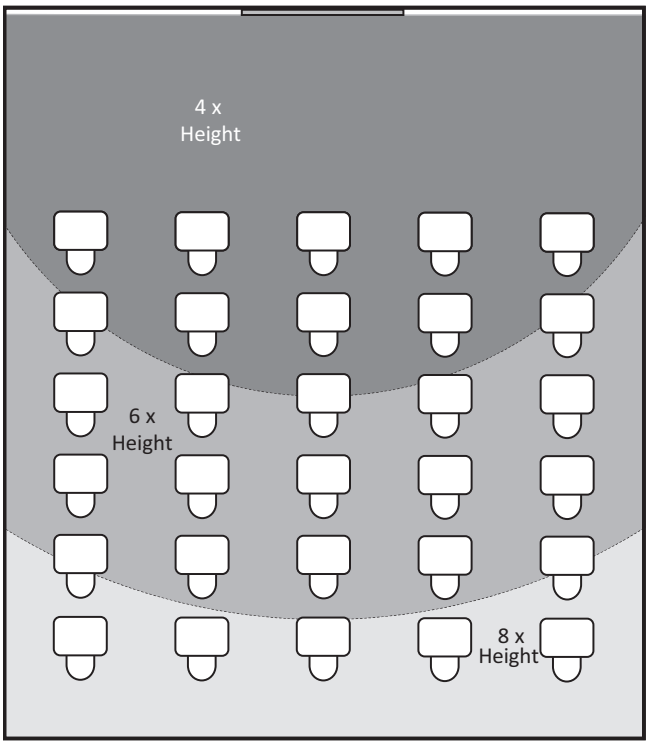
In this case, all of the 30 seats are within the 6× viewing distance for the 100" projection display, only the two additional seats are outside of that range. In fact, 40% of the seats are within the 4× viewing distance, making this an ideal arrangement for detailed work such as web browsing. The 65" FPD has a much lower coverage, with only 30% of the seats within the 6× viewing distance and 70% of the students beyond the 6×. The reduced room depth reduces the number of student beyond 8× to 20%, significantly better than the square room.

Deep Classroom

Older classrooms are often relatively deep or long, reflecting a traditional design approach. Figure 5 shows a typical deep classroom with desks in 6 rows.

Typical 896 Square Foot Classroom with 30 Desks (28 feet W x 32 feet D)

Classroom with 100 inch wall mount projector display



Classroom with 65 inch Flat Panel Display

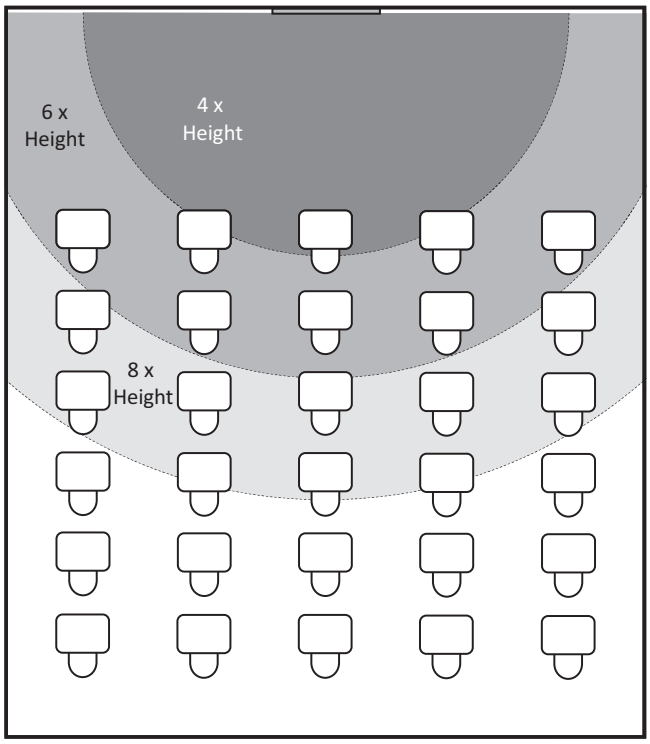


Figure 5 Deep Classroom Viewing Distances

In this longer room the advantages of the larger projection display are clear. Even with the 100" projection display, the last row of students as well as the side desks in the next to last row are just beyond the 6× viewing distance. However, the 65" FPD display has 70% of the students beyond the 6× viewing distance, but more importantly, a full 50% of the students are beyond the 8× viewing distance. Clearly, in this classroom a smaller display will have a dramatic impact on the effectiveness of display based learning and outcomes.

■ Summation of Room Viewing Distances

The best way to analyze is to look at the results in a summary form. The table in Figure 6 takes each room and the percentage of seats in each relative viewing distance for each display type.

Room Type	Room Size (Feet)			Percentage of Students in Range									
				100 Inch Diagonal Projection Display					65 Inch Diagonal Flat Panel Display (FPD)				
	Width	Depth	Square Feet	4x	6x	8x	Beyond 8x	Total Percentage Beyond 6x	4x	6x	8x	Beyond 8x	Total Percentage Beyond 6x
Square	30	28	840	27%	67%	7%	0%	7%	0%	20%	40%	40%	80%
Wide	22	44	968	40%	60%	0%	0%	0%	7%	27%	47%	20%	67%
Deep	32	28	896	37%	47%	17%	0%	17%	0%	27%	23%	50%	73%
Average			901	34%	58%	8%	0%	8%	2%	24%	37%	37%	73%

Acceptable Viewing Distance | Unacceptable Viewing Distance | Acceptable Viewing Distance | Unacceptable Viewing Distance

Figure 6 Classroom Viewing Distances Summary

The green columns are the 4× and 6× recommended viewing distances, the light red are any students seated so they are beyond the 6× viewing distance. Finally, at the bottom the room results are averaged. The result is that a 65 inch diagonal FPD in an average classroom will result in over 70% of the students having an experience that is less than ANSI standards recommend and an average of more than one third of the students beyond the 8× absolute maximum for any viewing. Clearly this will impact the student's ability to see and comprehend the information presented by the teacher on the display.

Conclusions

Clearly the size of the display in the classroom matters. The near ideal size of the wall mount projection display, with minimal room intrusion and optimal size is ideal for the average classroom. Choosing a small display will result in a significant reduction in the quality of the educational experience and will have a negative impact on educational outcomes and results.

EPSON®
EXCEED YOUR VISION

- **To learn more about Epson's portfolio of education solutions, visit us at epson.com.au/displaysizematters**

Epson Australia
3 Talavera Road, North Ryde, NSW 2113