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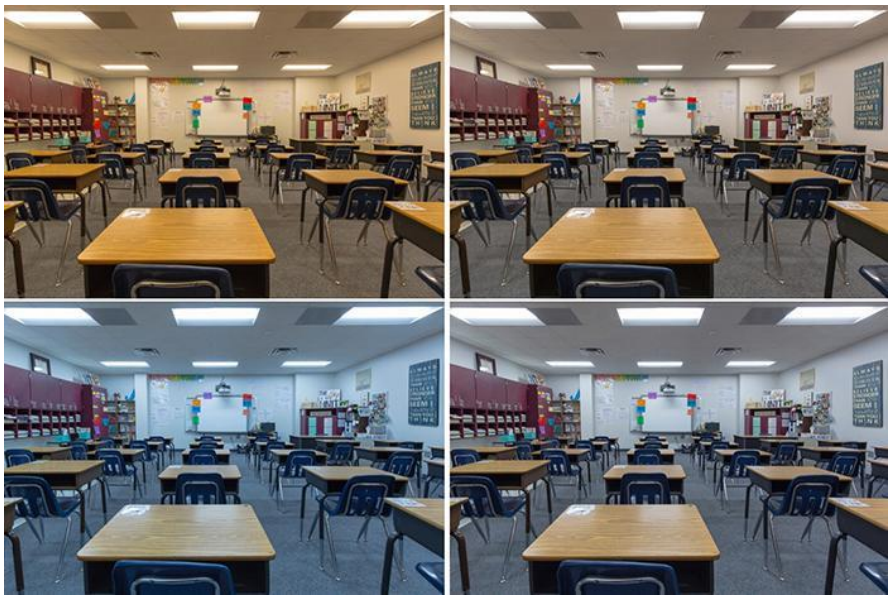
# A New Report on Tunable Classroom Lighting

A new GATEWAY report on a trial installation of tunable-white LED lighting systems in three Texas classrooms provides valuable insights into the use of this technology in a real-world setting. While reducing the energy used for lighting remains a priority for the school district, the district's objectives for the trial installation included considerations beyond energy savings — specifically, assessing the potential for tunable lighting to enhance teacher engagement with students and improve student performance.

Located in in the Carrollton-Farmers Branch Independent School District in Carrollton, TX, the three classrooms included a fifth-grade math and science classroom, a fourth-grade reading and language arts classroom, and an eighth-grade science laboratory. In August 2016, each incumbent recessed fluorescent luminaire in those rooms was replaced with a 2'x4' tunable-white LED luminaire with a CCT range of 3000 – 5000 K and a rated light output of 4600 – 5000 lumens. The lighting control system provides the ability to vary the spectral power distribution (SPD) across four preset conditions associated with nominal CCTs of 3000 K, 3500 K, 4200 K, and 5000 K. The controls also provide for preset scenes to vary the on/off status and dimming level of different luminaire zones within the room, to better support such classroom functions as audiovisual presentations and student speeches.



The reduction in input power for the tunable-white LED lighting system was estimated to be 58% relative to the incumbent fluorescent system. This reduction is attributable to the higher efficacy of the LED luminaires and a reduction in illuminances, which previously exceeded IES-recommended levels. Dimming — which was incorporated into the scene controls and also enabled by separate dimming controls — furthered the energy savings in each classroom. While the teachers' individual usage of the controls varied widely as recorded by the monitoring

system, in each case the lighting consistently operated with all or some of the luminaires turned off or dimmed for portions of the school day.

The LED lighting systems were installed and commissioned with very few difficulties, and any issues with initial performance were quickly resolved. The three teachers used the scene controls regularly during the school day but used the SPD controls infrequently. As was the case with the incumbent fluorescent systems, illuminance levels in the classrooms at maximum output met or exceeded IES recommendations for the typical visual tasks with the new LED systems.

Color consistency for the tunable-white LED luminaires was very good, even over the dimming range, with only minor variations in CCT and $D_{uv}$. The two teachers interviewed by DOE appreciated the ability to tailor the lighting to different classroom needs, and felt that the lighting and controls allowed the students to be engaged in choosing the settings for various classroom activities. Both teachers stated that the lighting system improved the overall learning environment.

Although most teachers are unfamiliar with CCT and other lighting metrics related to color quality, labeling lighting control settings with familiar terms may provide barriers to full usage of the controls. In this project, labels such as "Reading," "Testing," and "Energy" tended to be interpreted too narrowly by the teachers, who didn't seem to use those control settings for classroom functions that didn't match the labels. The "General" control setting served as the default.

Use of lighting controls may be enhanced when the control locations are convenient for the teacher. The control locations for this project were constrained by the existing wiring, and where the control locations were more easily accessed by the teacher, the settings (specifically, the dimming level) were varied more regularly than when the controls were less accessible for the teacher.

The combination of spectral tuning and dimming in the classrooms provides greater opportunity to vary lighting parameters that may affect circadian and behavioral responses for students, teachers, and other users, relative to the fluorescent systems. While documenting these circadian and behavioral effects was beyond the scope of this project, the tunable LED systems may be adaptable to reinforce the desired outcomes, should scientific consensus emerge that supports specific SPD and intensity settings for related effects.

Energy savings from tunable classroom systems results from the switching and dimming functionality of the scene control settings and the manual dimming controls; the ability to vary the color quality doesn't necessarily provide additional energy savings. Because color-tunable systems are at present more costly than fixed-color LED systems (which can still provide full scene and dimming control), an economic argument for color-tunable systems can't be based on energy alone. As with other classroom upgrades, the justification for color-tunable lighting systems needs to include non-energy benefits related to a better learning and working environment, possibly linked to student learning outcomes, teacher satisfaction and retention, and human-health impacts. The difficulty in documenting and assigning economic value to these potential non-energy benefits poses a major challenge for color-tunable lighting systems in classrooms and other applications.

For the complete findings, download the full report.

Best regards,
Jim Brodrick

As always, if you have questions or comments, you can reach us at postings@akoyaonline.com.