What effect does artificial light have on student learning?

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Introduction

No studies have compared light emitting diode (LED) lighting against incandescent lighting in school environments, and most previous studies on lighting effects on students have mainly focused on measuring mental performance. Other skills, such as creativity and memory, have only rarely been considered. In three experiments with a total of six classes from three schools, we investigated whether the conversion from incandescent lighting to LED lighting changed students' behaviours. For all studies, the colour temperature and light intensity were as similar as possible.

Method

To avoid any teaching disturbances, testing tasks were designed to be similar to typical classroom exercises.

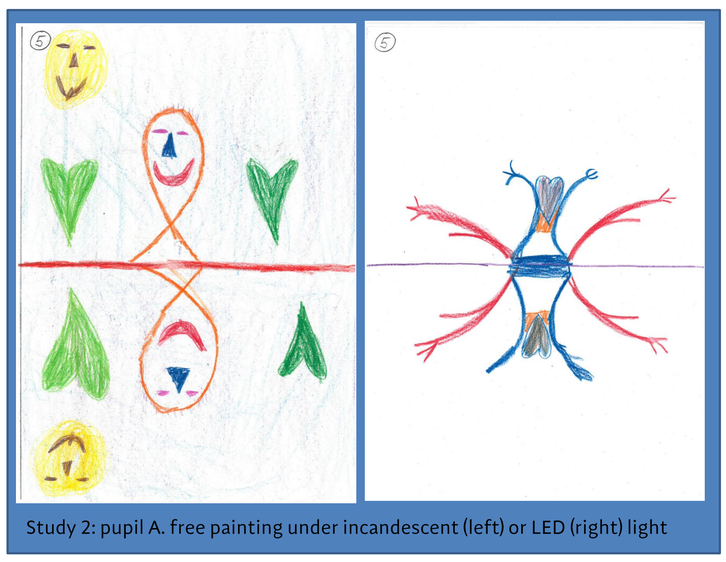
Lighting of the first and third study		
Halogen	Halolux Ceram®	150 W 2870 lm, 2900 K
LED	Luxwerke x.course	34 W, 4300 lm, 2700 K

Lighting of the second study		
Incandescent light	Osram	100 W
LED (warm white)	Philips	13 W 2700 K

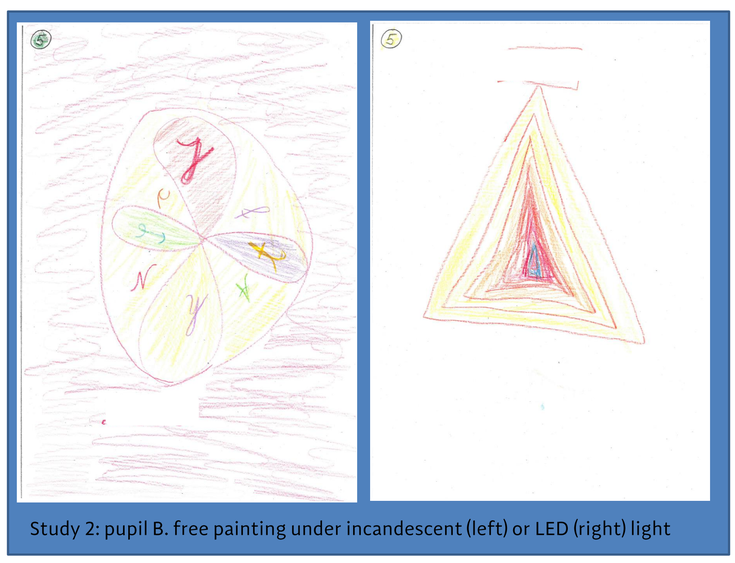
First study, class 5 (2016)		Dictation (n=16)	Open retelling (n=22)	Copy text (n=20)
Week 1	LED	Mistakes	Mistakes and completeness	Mistakes and Completeness
Week 2	Halogen			
Week 3	Halogen			
Week 4	LED			

Second study (2017)		Class 3 (n=34)	Class 5 (n=22)	Class 7 (n=26)	Tasks
Week 1	Two days	Incandescent light	LED	Incandescent light	Dictation, copy text, open retelling, mental calculation, painting
Week 2	Two days	LED	Incandescent light	LED	

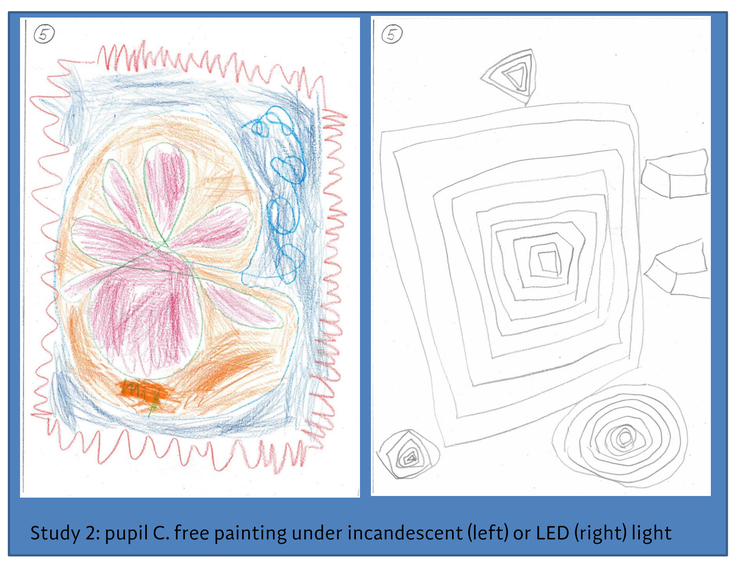
Third study (year 2018)	Class 4 (n= 21/26)	Class 6 (n=13/20)	Tasks			
Week 1	LED	Halogen	Image description	Search image	Memory test open retelling / copy text	Creativity painting of a free image
Week 2	Halogen	LED				
Week 3	LED	Halogen				
Week 4	Halogen	LED				



Study 2: pupil A. free painting under incandescent (left) or LED (right) light



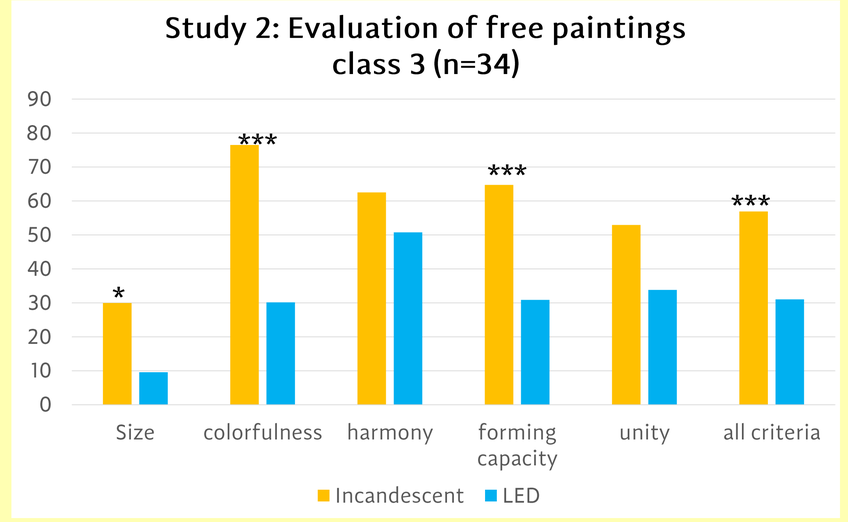
Study 2: pupil B. free painting under incandescent (left) or LED (right) light



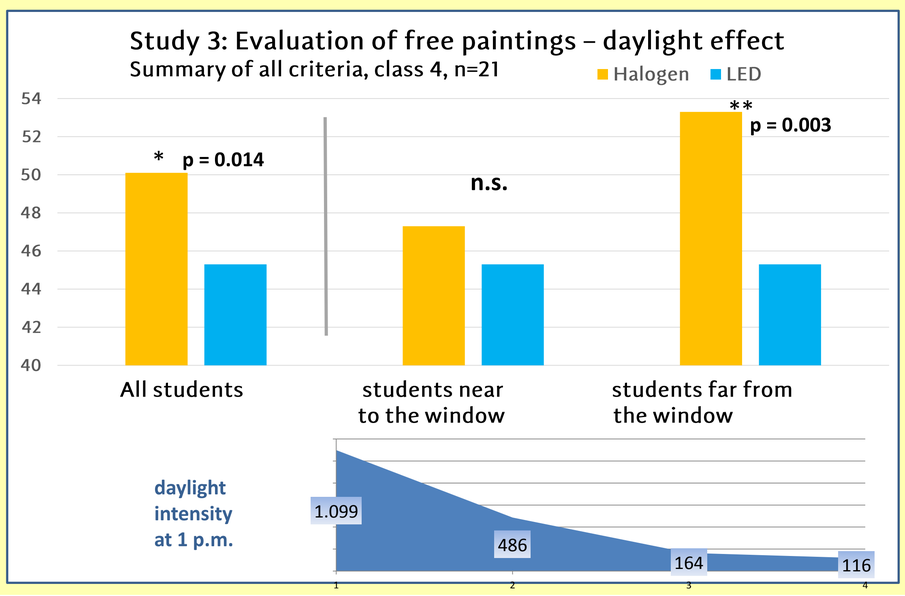
Study 2: pupil C. free painting under incandescent (left) or LED (right) light

Results

In most of the cases, students performed better under halogen / incandescent lighting compared to LED lighting. In addition to painting capacity (see graphs), differences occurred in both dictation and memory tests. In the first study, mistakes in orthography (four cases) under LED lighting were between 116% and 313% compared to halogen lighting (100%). In open retelling and text copying, more mistakes occurred in the use of correct verbs and tenses under LED lighting. In the second study, the students from class 7 performed better under incandescent lighting concerning text length of open retelling (LED: 59%), mistakes in dictation (LED: 213%) and mistakes in mental calculation (LED: 109%). In class 5, the mistakes under LED were 172% (copy text) and 114% (dictation) compared to incandescent lighting. In class 3, in two exercises pupils performed better under LED lighting (dictation 88% and mental calculation 86%). In text copying, more mistakes occurred under LED lighting (140%).



Class 3 painted free pictures twice. In both cases, pictures under incandescent lighting were evaluated better, with significant differences in 3 of 5, resp. 5 of 5 criteria of painting capacity.
In the third study in class 4, visual recognition (description of a photo) improved under LED lighting (107%), while length of open retelling (94%) and drawing capacity were reduced (90%).
In class 6, length of open retelling (80%) and of drawing capacity was reduced under LED lighting (95%) compared to halogen lighting (100%).



Effects on lighting on students`behaviour. Which lighting regime performed better?
Summary of three studies

Skills	*Alertness, concentration*	*Memory*	*Creativity*	*Visual recognition*
Exercises	Mistakes in writing and calculation	Text copying, open retelling (completeness, text length)	Drawing of pictures	Written scene description, picture search
Study 1 Class 5				
Study 2 Class 3	not significant			
Study 2 Class 5				
Study 2 Class 7				
Study 3 Class 4		not significant		
Study 3 Class 6	not significant		not significant	not significant

= better with LED light
= better with incandescent or halogen light
= hachures: a part of the exercise results are significantly different
= not detected

Conclusions

Although some studies show improvements in cognitive performance under the blue light of LED lighting in school environments, education addresses other skills, such as memory and creativity. Our experiments show that, in some cases, lighting clearly affects the quality of students' performance. The results indicate that LED lighting causes deficits in memory and creativity as compared to incandescent lighting.

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References:
Geier, U. (2018). Practical Investigation of the Impact of Classroom Lighting on Student Behaviour: A Comparison of LED and Incandescent Light. In Preparation.
Keis, O. et al. (2014). Influence of blue-enriched classroom lighting on students`cognitive performance. Trends in Neuroscience and Education 3, 86-92.