Dynamic Lighting in Classrooms.
A mixed method study of light, behavior and sound.
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Dynamic Lighting in Classrooms
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Content

A mixed method study of light, behavior and sound

1. Lighting Design Research Group Aalborg University, Cph.
2. Review of Literature – need for mixed methods
3. Case-study: combining light, sound and behavior
4. Analysing patterns from different parameters, mixing methods
5. Case study: Simulations
6. Future work
This newly established research group (2015) with its center on the Aalborg University campus in Copenhagen has as its mission to contribute to new and improved ways as to how we use and perceive light in our daily lives.
Dynamic Light in Classrooms

A mixed method study of light, behavior and sound

Validating the impact of Dynamic light on the learning environment - A review on methods

A review of 22 papers studying the impact of lighting on learning environments.

Above half of the papers apply only quantitative data and academic performance.

Only one third use mixed methods.

The Impact of Dynamic Light on The Learning Environment

A mixed method study of light, behavior and sound

The review of the papers lead to the conclusion:

Lighting in the learning environment should be studied and designed holistically through a transdisciplinary mixed method approach involving the users.
Case Study “Light & Learning”
A mixed method study of light, behavior and sound

How can mixed methods be applied in lighting Design?

An initial case study was conducted in classrooms in a middle-school near Copenhagen.

The aim was to create holistic evidence-based knowledge on what parameters to integrate in the design of new dynamic lighting at the school.
To develop design parameters based on users needs, the case-study investigated the activities, behavior of students through sound, the use of space and the lighting.

To investigate behavior, sound was identified as a measurable parameter.
Case Study: Methods

A mixed method study of light, behavior and sound

The data collected was structured into three categories:

- **Light**: photos, measurements, structured observations, interviews.
- **Behavior**: structured observations, interviews, sound and photos.
- **Activities**: structured observations, interviews.
To correlate the parameters a quantification of observations, brightness and behavior took place. Interviews were used to support the statistical analysis.

Rating scale: 1 calm behavior and 5 noisy and disruptive behavior
Correlations were analysed by comparing patterns of brightness, sound and behavior over time.

This demonstrates a methodology that can be used to define holistic design scenarios crossing boundaries between qualitative and quantitative design criteria and research methods.

Rating scale: 1 calm behavior and 5 noisy and disruptive behavior.
The **users needs** were translated into **design parameters** and used to develop dynamic lighting design solution.

*Case Study “Light & Learning”*

Studying two classrooms facing east and west
# Case Study: From analysis to design criteria

A mixed method study of light, behavior and sound

<table>
<thead>
<tr>
<th>Criteria groups</th>
<th>Criteria</th>
<th>Methods for measuring</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activities and behavior</strong></td>
<td>Reduced sound levels</td>
<td>Sound measurements</td>
</tr>
<tr>
<td></td>
<td>→ to a maximum of 60 dB during class - SoundEar recommendations (1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The students are less distracted (especially in the afternoon)</td>
<td>Observations</td>
</tr>
<tr>
<td></td>
<td>→ not going above 3 on the scale</td>
<td>Interviews</td>
</tr>
<tr>
<td></td>
<td>→ the students and teachers express feeling more focused in the afternoon</td>
<td></td>
</tr>
<tr>
<td><strong>Comfort and Visibility</strong></td>
<td>Reduced discomfort glare and eye strain issues caused by sunlight</td>
<td>Interviews with students</td>
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<tr>
<td></td>
<td>→ not being mentioned as a problem in interviews</td>
<td></td>
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<tr>
<td></td>
<td>Improved visibility of the smartboard</td>
<td>Interviews with students</td>
</tr>
<tr>
<td></td>
<td>→ not being mentioned as a problem in the interviews</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improved visibility at desk level</td>
<td>Light measurements</td>
</tr>
<tr>
<td></td>
<td>→ illuminance levels and uniformity are up to the standard DS/EN 12464</td>
<td></td>
</tr>
<tr>
<td><strong>Interaction with light</strong></td>
<td>Conscious use of the lighting as a tool to influence the learning activities</td>
<td>Observations</td>
</tr>
<tr>
<td></td>
<td>→ the teachers change the scenarios at least 3 times per hour</td>
<td>Interviews with teachers</td>
</tr>
<tr>
<td></td>
<td>→ they are aware of how the lighting is influencing the classroom activities</td>
<td></td>
</tr>
</tbody>
</table>

(1) SoundEar (2015) SoundEar®3 UK Manual ver.2 26.05.2015
https://dl.dropboxusercontent.com/u/59214245/Manualer/SoundEar3/SoundEar3_UK_manual%20ver.2%2026.05.15.pdf
Case Study: Simulations of Three Lighting Scenarios

A mixed method study of light, behavior and sound

1. High illuminance
2. Even distributed light
3. Neutral CCT

1. Low illuminance
2. Warmer CCT

1. Wallwashers
2. Cooler CCT
3. High illuminance

Three lighting scenarios based on the design criteria
Future Work

Currently an evaluation is running investigating how the implemented dynamic lighting scenes affect the learning and teaching environment.

Combining sound, observations of behavior and activates, tracking the teachers use of light scenarios, and focus groups will be used to study the relationship between the light and learning.

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