NEW CONCEPTS FOR TOMORROW'S LEARNING SPACES

A RESEARCH INTERVENTION STUDY

AN INTERVENTION STUDY

This presents the results of exploring the learning spaces of tomorrow.
The project was carried out in collaboration between the University of Gävle, Edith Cowan University, the University of Melbourne, and the companies Fagerhult and Lekolar.
The project was funded by the Knowledge Foundation (KK Foundation), the project brought together researchers and industry partners to develop new knowledge about how learning spaces can better support teaching and learning.

Anneli Frelin, Professor of Didactics - Gävle högskola
Jan Grannäs, Senior Lecturer and Associate Professor in Didactics - Gävle högskola
Wesley Imms, Professor Primary school of learning sciences - The University of Melbourne
Malin Jarbo, Range & Concept manager - Lekolar
Jacob Lejdström, Light designer - Fagerhult
Julia Morris, Education researcher and Associate Professor - Edith Cowan University Perth
Maria Svensson, Spatial designer - Lekolar
Kjell Wallin, Senior light adviser - Fagerhult
Therese Östlin, Lecturer in Educational Sciences Gävle högskola

ECU EDITH COWAN UNIVERSITY

FAGERHULT

HÖGSKOLAN I GÄVLE

lekolar®

THE UNIVERSITY OF MELBOURNE

Can innovative combinations of lighting and interior design create more user-friendly learning spaces that better support innovative teaching methods?

21ST CENTURY SKILLS & INNOVATIVE PEDAGOGIES

OECD

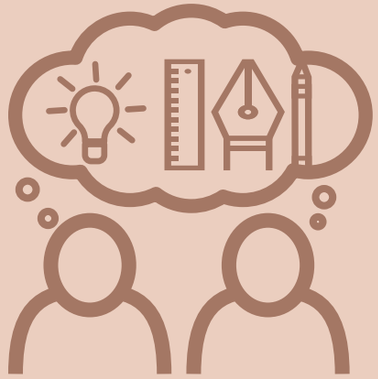
OECD has played a key role in promoting the concept of 21st century skills, reflected in the OECD Learning Compass 2030, a framework co-developed with policymakers, researchers, school leaders, teachers, students and stakeholders from more than 40 countries and jurisdictions worldwide.

COMMUNICATION

Articulate thoughts and ideas effectively in a variety of forms and contexts. Listen actively and respond thoughtfully. Use a range of technologies to communicate and collaborate.

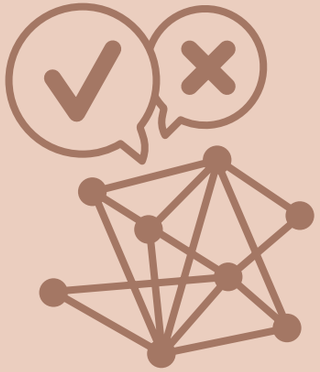
COLLABORATION

Work effectively and respectfully with others. Demonstrate flexibility and compromise to achieve shared goals. Take collective responsibility and value each team member's contribution.



CREATIVITY

Think creatively, both independently and collaboratively. Develop and implement innovative ideas. Apply creative thinking to real-world situations and challenges.



CRITICAL THINKING

Reason effectively, including on complex issues, using systems thinking. Exercise sound judgement in decision-making. Identify, analyse, and solve problems.

SWEDISH LANGUAGE FOCUS

READING & WRITING

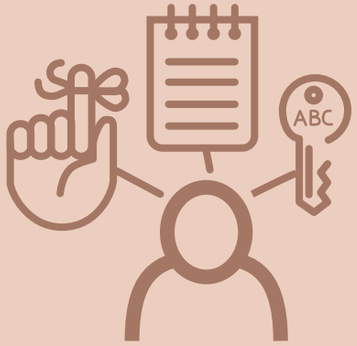
Read, interpret and analyse texts from different media. Identify key messages, themes and meaning.

SPEAKING, LISTENING & DISCUSSION

Present, discuss and communicate ideas clearly. Adapt language and content to different audiences and purposes.

TEXTS

Understand and create different types of texts. Recognise structure, purpose and key language features.



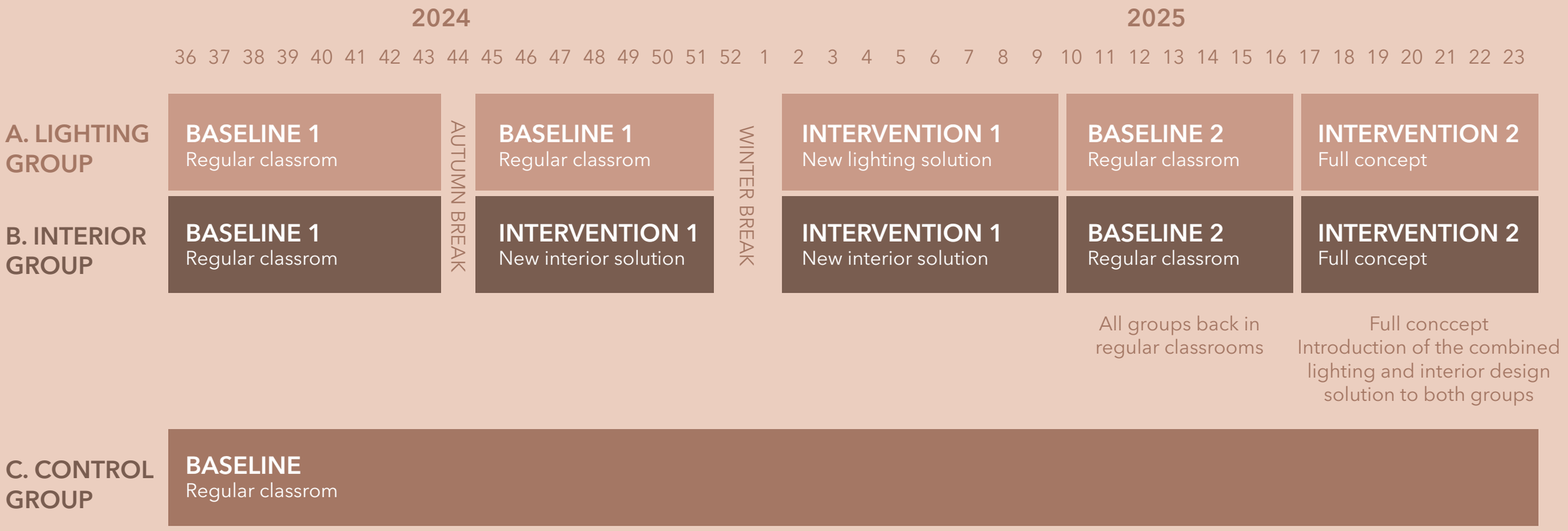
LANGUAGE USE

Use note-taking, keywords and other strategies to support learning, memory and understanding.

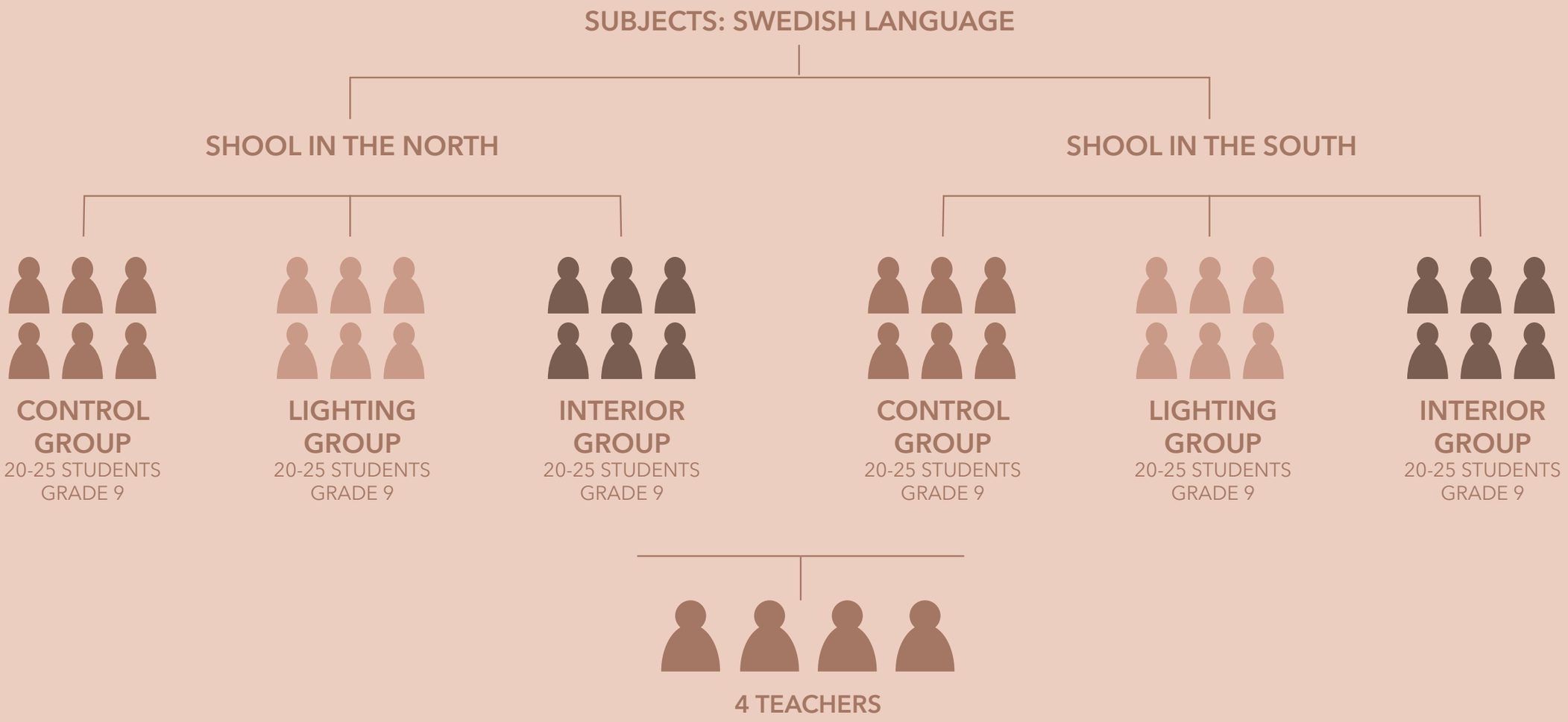
INFORMATION SEARCH AND SOURCE CRITICISM

Search, select and evaluate information. Apply critical thinking when assessing sources and reliability.

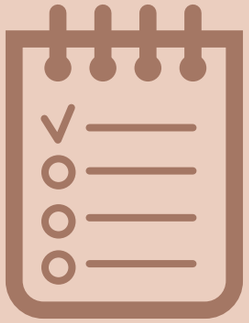
REPEATED MEASURES DESIGN



SET UP INTERVENTION



DATA SOURCES



STUDENT SURVEYS

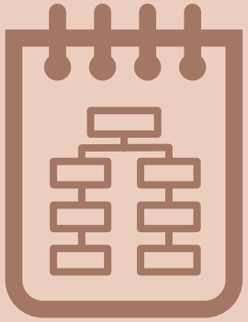
All ninth-grade students completed surveys every other week.

1240 surveys

TEACHER INTERVIEWS

Four occasions during the school year.

16 interviews



TEACHER LOG

Following each lesson, teachers completed log entries documenting the organization of activities and the use of the classroom during that session.

354 logs

SENSORS

The sensors, integrated into the luminaires, used infrared light to identify occupied and unoccupied areas and recorded these usage patterns. 20 sensors in total.

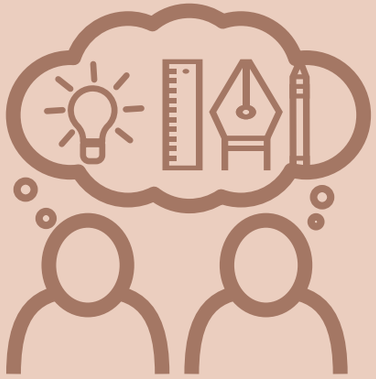
STUDENT SURVEY

FOCUS

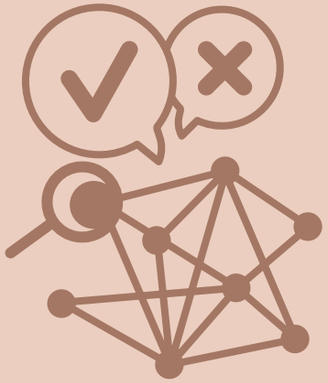
Do Interior design and lighting support your ability to focus on learning.

COMMUNICATION

COLLABORATION



CREATIVITY

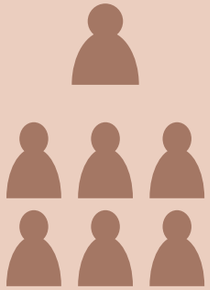


CRITICAL THINKING

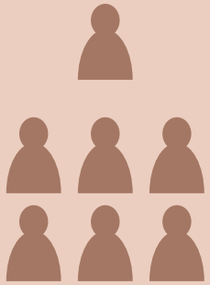
Student reflections on their ability to develop C4 skills

TEACHER LOG

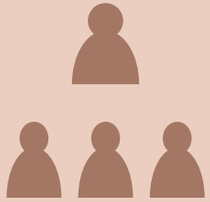
HOW WAS THE TEACHING ORGANIZED:



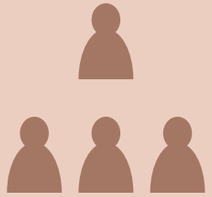
Teacher-led
whole-class teaching



Student-led
whole-class presentations



Teacher-led
small-group teaching

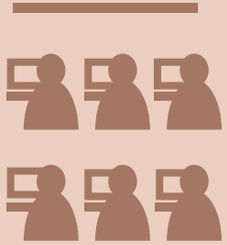


Student-led
small-group presenta-
tions

Group or pair work
with teacher support
if needed

Individual work
with teacher support
if needed

Independent
assessment work
(e.g. tests/exams)



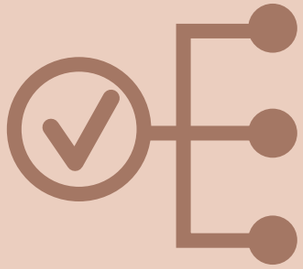
Technology-supported
whole-class learning

Other

TEACHER INTERVIEWS

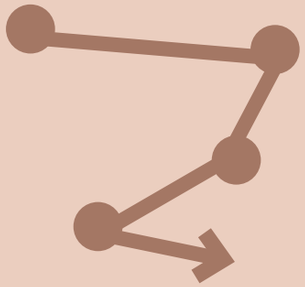
INTERVIEW

A series of structured interviews with teachers was conducted at four points during the academic year using Zoom. All interviews were audio recorded following informed consent.



ORGANIZATION

How teachers planned, structured, and conducted their teaching activities.
The types of learning activities used, including whole-class instruction, group work, and individual work.



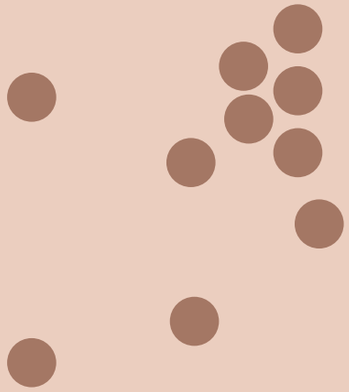
USE

How teachers utilized the physical learning space during different phases of the study.
How spaces, furniture, and resources were adapted to different teaching and learning activities.

PERCEIVED IMPACT

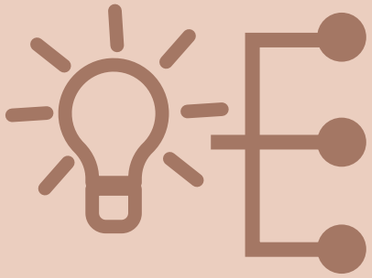
Teachers' experiences of how the learning space supported their teaching practice.
How the environment facilitated pedagogical approaches aimed at fostering:
Communication, Collaboration
Creativity, Critical thinking

SENSOR DATA



SPATIAL UTILIZATION

Integrated infrared sensors continuously recorded which areas of the classroom were occupied or unoccupied, providing data on how different parts of the space were used over time.

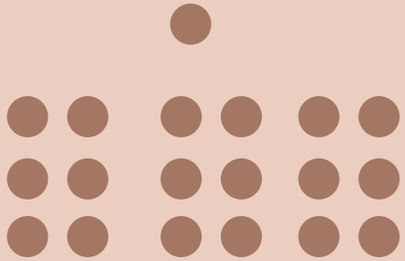


LIGHTING SCENE USAGE

Sensor data was linked to the active lighting scenes at the time of each recording, enabling analysis of space utilization in relation to lighting conditions.

NEEDS ANALYSIS

BASELINE -REGULAR CLASSROOM



INTERIOR

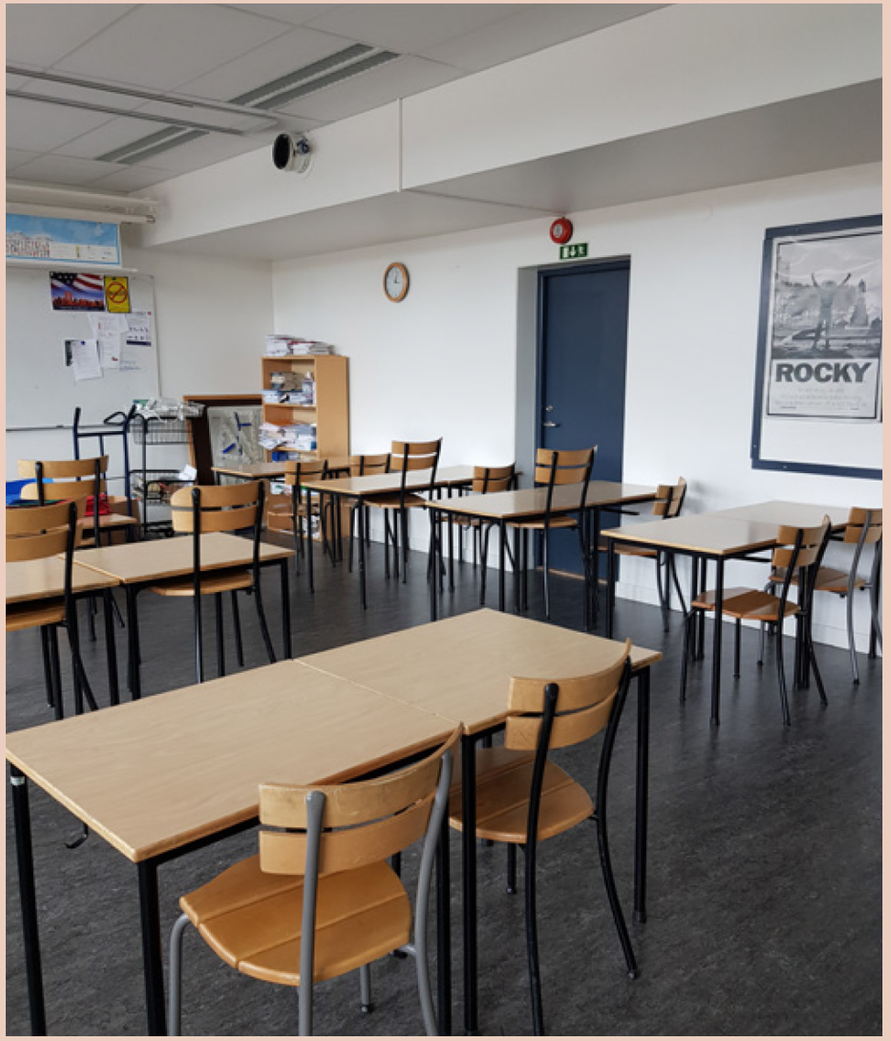
The rooms were traditionally furnished with single- or double-student desks and chairs. Shelving units or storage cabinets were located along the walls. A teacher's desk or lectern situated at the front of the room, either centrally or to the left side.

LIGHTING

Classrooms equipped with fluorescent or compact fluorescent lighting, including dedicated lighting along the whiteboard.

TECH

A projector or LED display positioned at the front of the classroom. Students have laptops.


ROCKY

NEEDS ANALYSIS - WORKSHOP

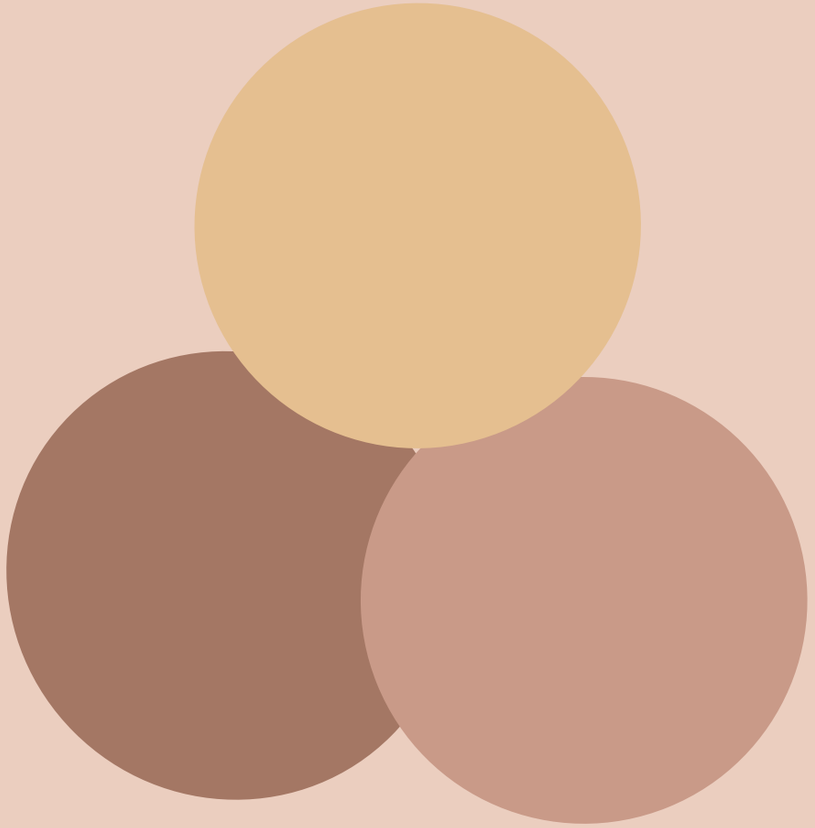
- Seating lacks ergonomic variety: chairs are undersized, uncomfortable, and noisy, while fixed-height furniture does not accommodate different body sizes.
- Heavy, non-mobile furniture limits rapid reconfiguration for varied teaching methods.
- Classrooms feel sterile and lack identity.
- Display space for books and student work is insufficient.
- Limited screened, quiet zones hinder focused work, particularly for students with neurodevelopmental conditions (NDCs).
- The spatial design does not fully support flexible, collaborative, and diverse learning.

FOKUS FOR INTERIOR SOLUTION

- ERGONOMICS & SPATIAL MOVEMENT Improve ergonomics and freedom of movement through lighter, height-adjustable furniture.

- VARIETY Create variety (interior) and privacy through zoning and movable screenss.

- IDENTITY Enhance well-being and strengthen the identity of the space through the use of colour, texture, and opportuni-



IMPROVE ERGONOMICS AND SPATIAL MOVEMENT

Student chair

Single table

Height adjustable table

Group table

Teacher chair

Teacher table

ENHANCE WELL-BEING AND STRENGTHEN THE IDENTITY OF THE SPACE

Space-dividing furniture

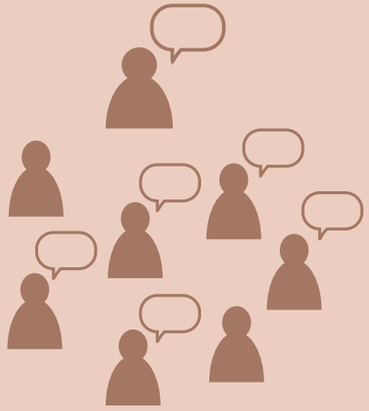
Sofa table

Modular sofa

Mobile whiteboard

Book display

VARIETY - ZONE DIVIDED SOLUTION



ACTIVE ZONE

- INSTRUCTION AND DISCUSSION

The layout and positioning of the furniture ensure that both teachers and students can see one another clearly, facilitating whole-class instruction, discussions, and dialoguecentrally or to the left side.

FOCUS ZONE

– INDEPENDENT WORK

Larger tables can easily be separated into individual workstations. Desk screens are available to provide additional privacy and reduce distractions when needed.

CREATIVE ZONE

– GROUP AND PROJECT WORK

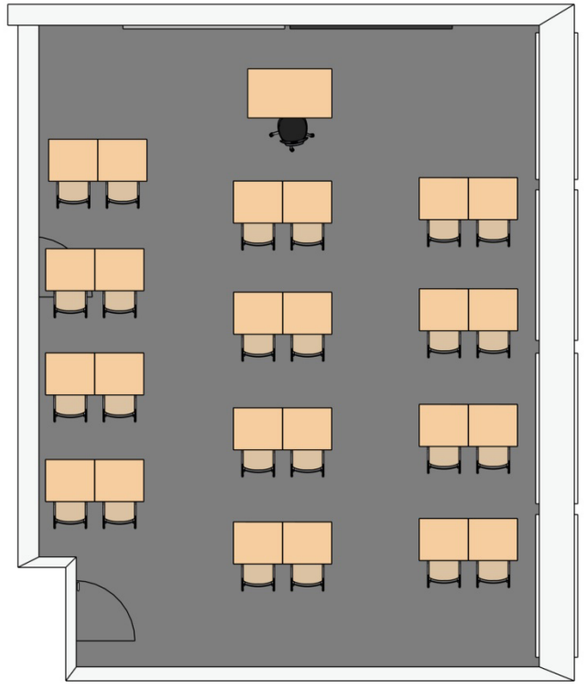
Round tables and soft seating arrangements support collaboration by enabling all participants to see and interact with one another. This environment fosters creativity, communication, and collaborative problem-solving.

INTERIOR DESIGN SOLUTION

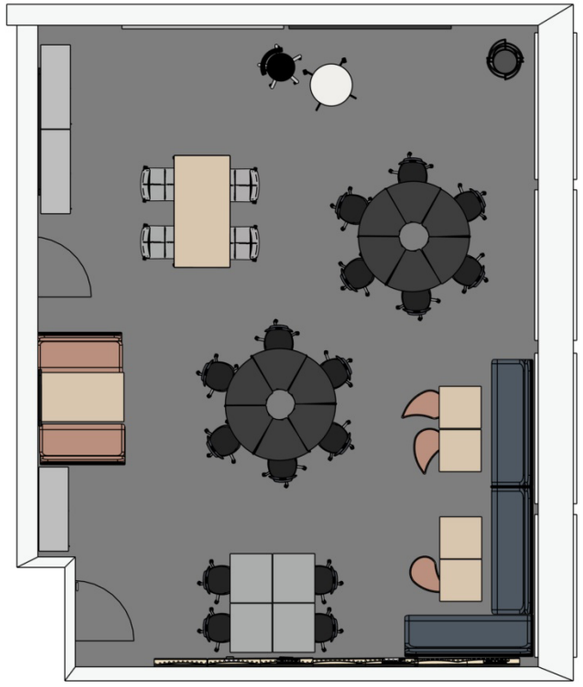
School in the North - 67m2

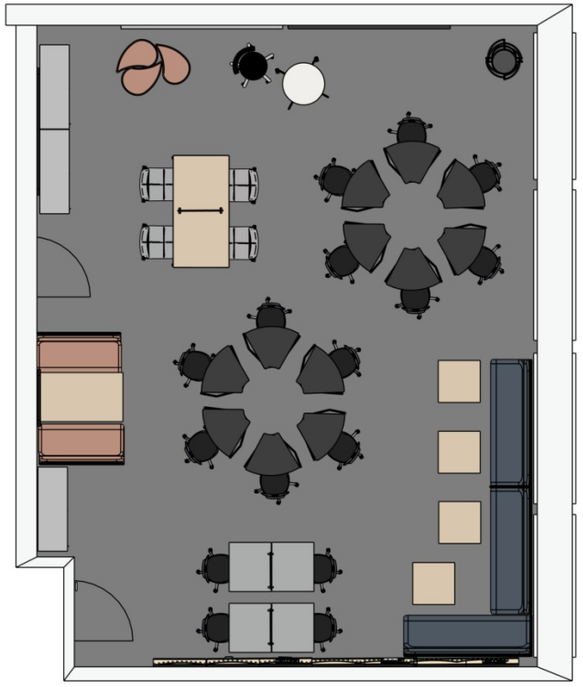
School in the South - 60m2

NORTH SCHOOL TRANSFORMATION



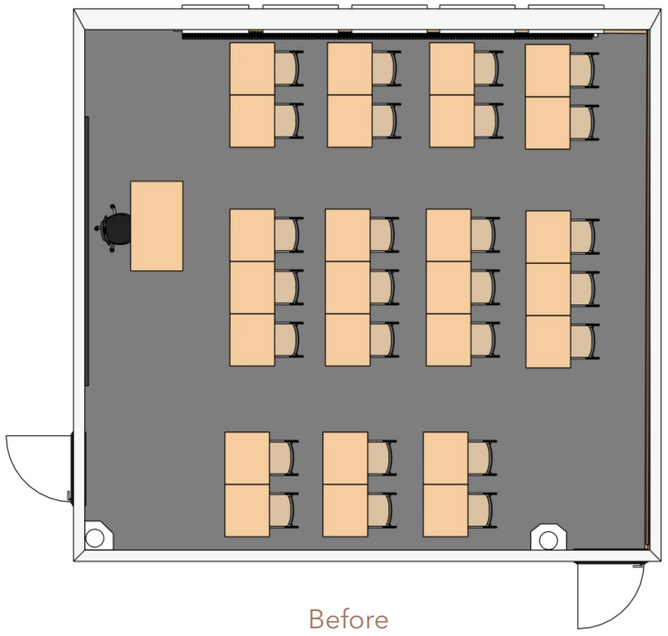
Before



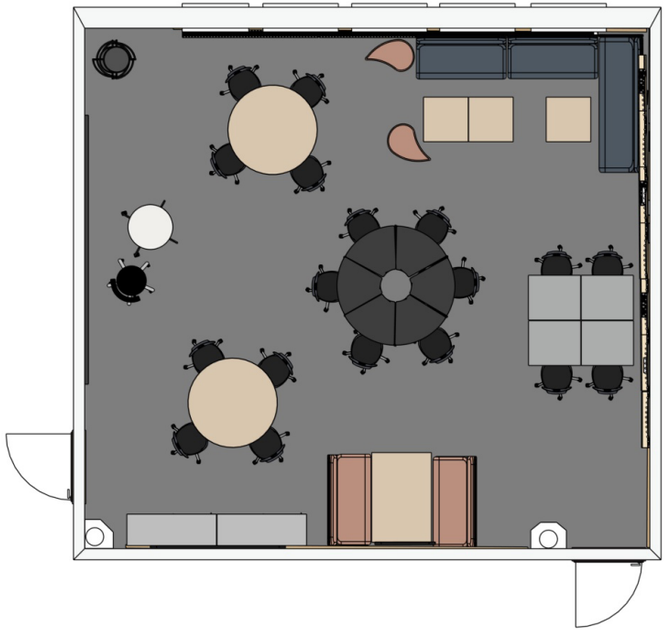


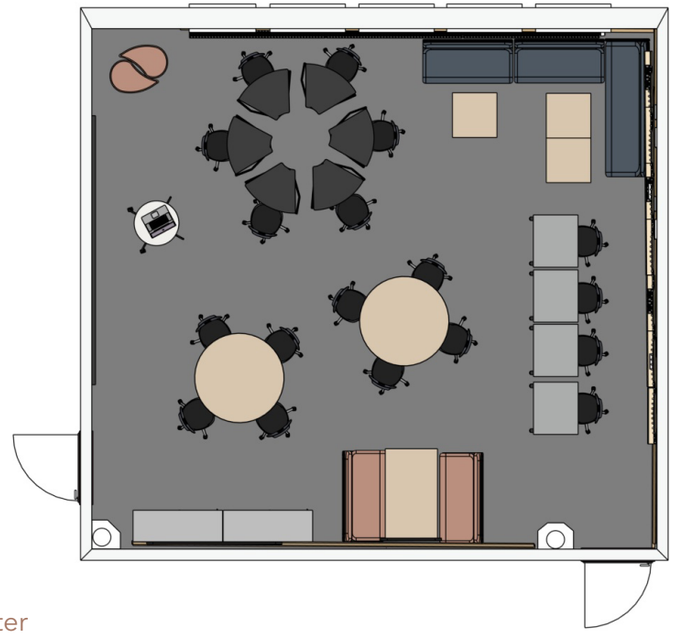
After

SOUTH SCHOOL TRANSFORMATION



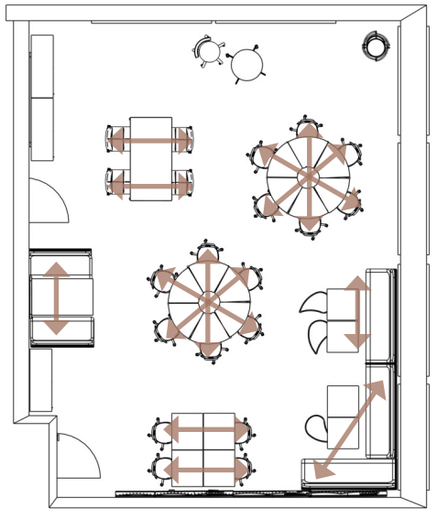
Before



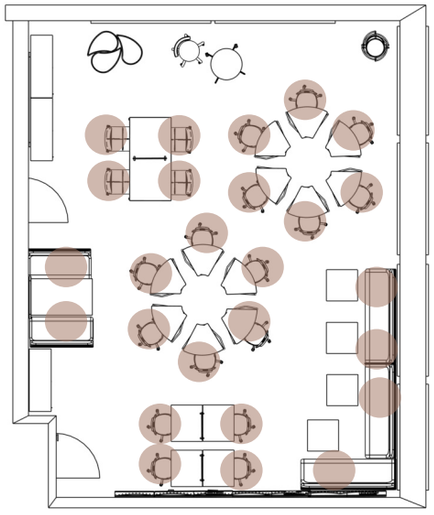


After

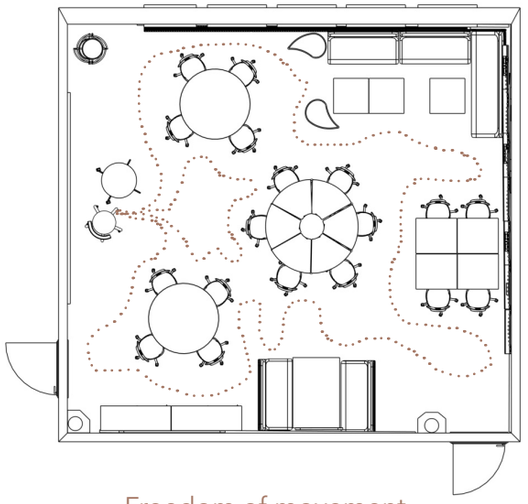
SPATIAL DESIGN FOCUS



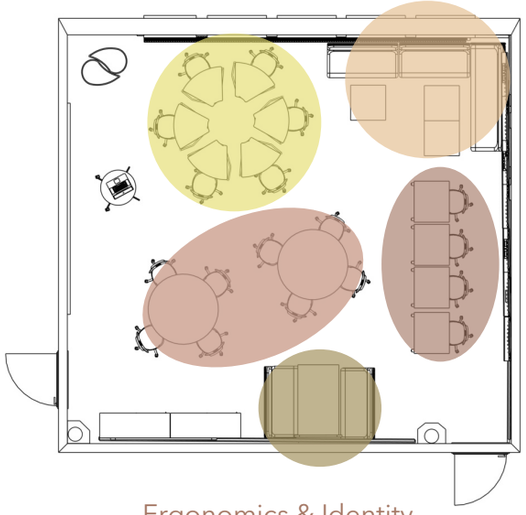
Interact



Privacy



Freedom of movement



Ergonomics & Identity

INTERIOR SOLUTION

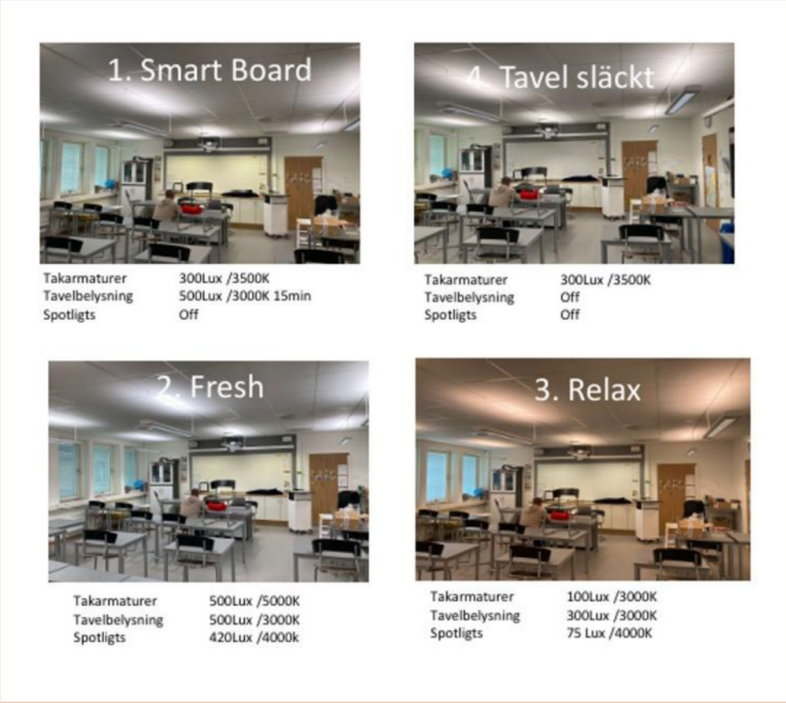
INTERIOR SOLUTION

INTERIOR SOLUTION

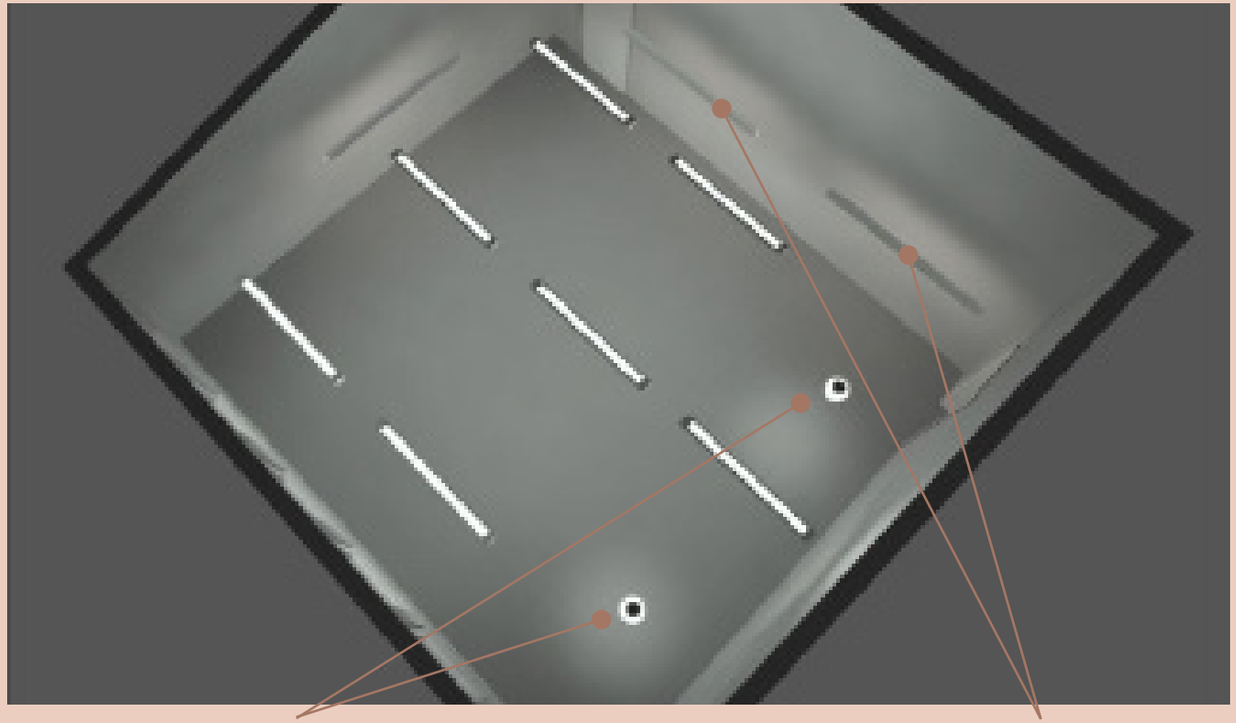
NEEDS ANALYSIS - LIGHT

- Students report experiencing headaches.
- Students become tired and struggle to maintain focus.
- Limited to almost non ability to adjust the lighting.
- Most students prefer not to sit near the dark interior wall.

INTERVENTION 1 LIGHTING - THEME BASED SYSTEM



THEME-BASED SYSTEM
4 pre-set scenes

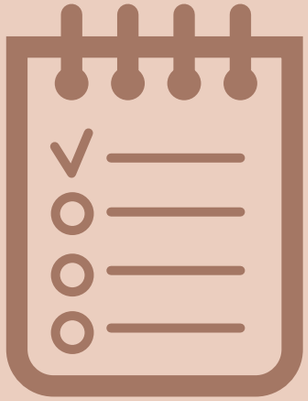


PENDANTS
at back of room: equalise all seats

VERTICAL WALL LIGHTING
compensates for lost daylight

COMBINED SOLUTION

QUANTITATIVE RESULTS

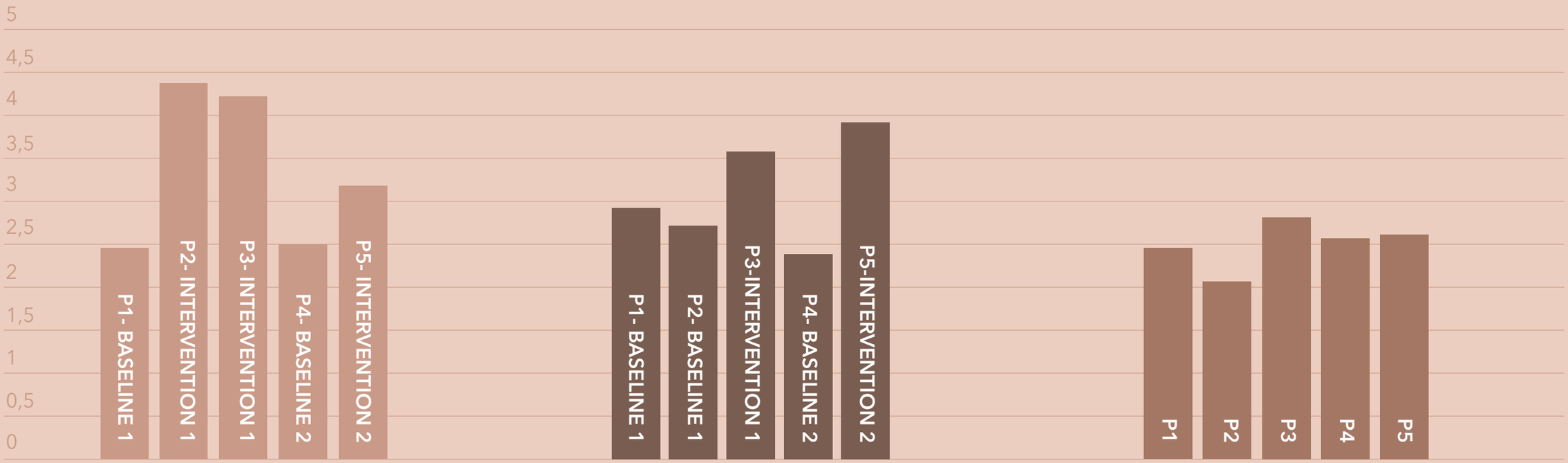


STUDENTS SURVEY

FOCUS

HOW INTERIOR DESIGN AND LIGHTING SUPPORTS STUDENTS' ABILITY TO FOCUS ON THEIR LEARNING.

Avarage during the period, scale from very negative to very positive



INTERIOR GROUP

P1) Regular classroom
P2) New interior solution
P3) New interior solution
P4) Regular classroom
P5) Combined interior & lighting solution

LIGHTING GROUP

P1) Regular classroom
P2) Regular classroom
P3) New lighting solution
P4) Regular classroom
P5) Combined interior & lighting solution

CONTROLGROUP

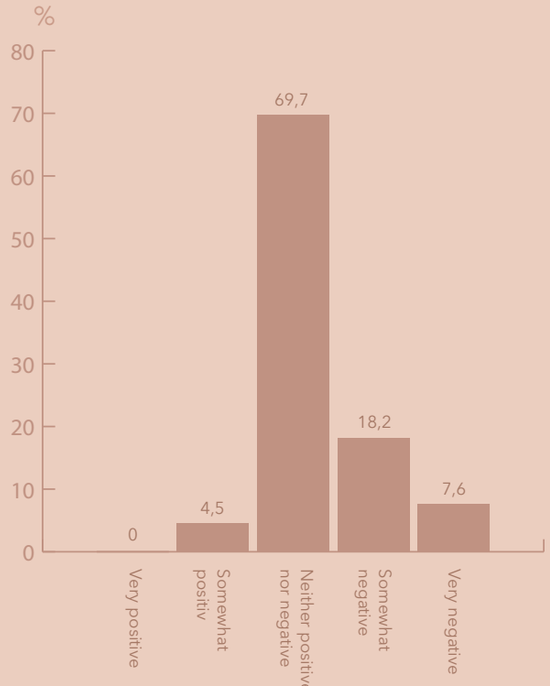
P1) Regular classroom
P2) Regular classroom
P3) Regular classroom
P4) Regular classroom
P5) Regular classroom

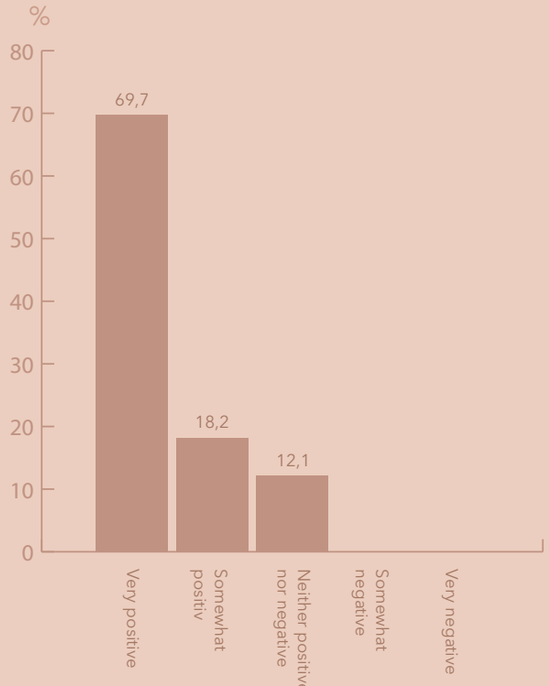
FOCUS INTERIOR GROUP

HOW DID INTERIOR DESIGN EFFECT YOUR ABILITY TO FOCUS ON YOUR LEARNING.

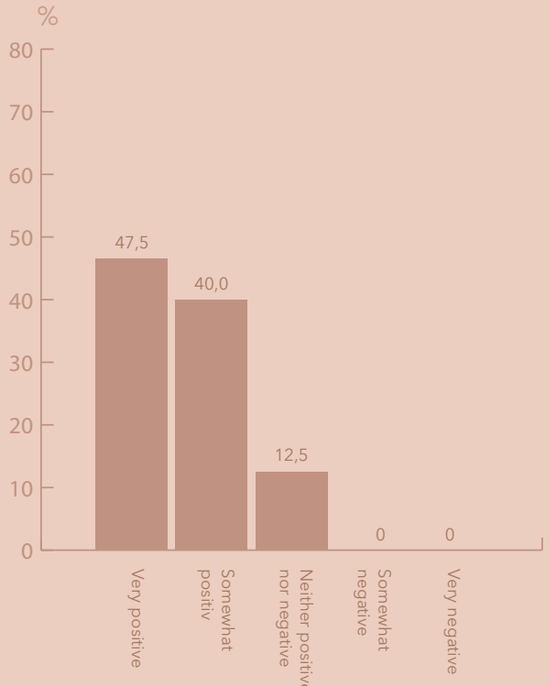
From baseline to intervention1

SCHOOL IN THE NORTH



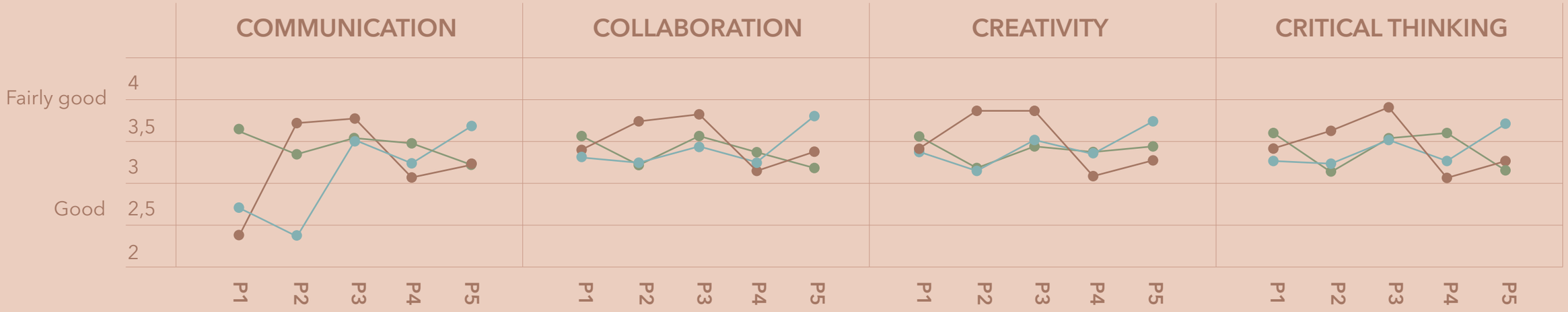


SCHOOL IN THE SOUTH



21ST CENTERY SKILLS

STUDENT REFLECTIONS ON THEIR ABILITY TO DEVELOP C4 SKILLS IN THE PERIOD
Very good, Fairly good, Good, Fairly bad, Bad.

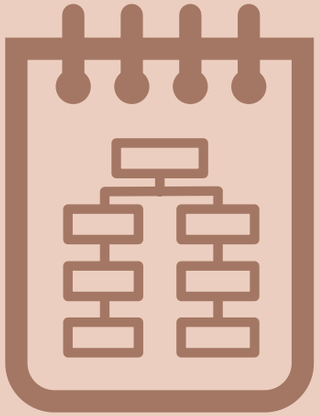


INTERIOR GROUP
P1) Regular classroom
P2) New interior solution
P3) New interior solution
P4) Regular classroom
P5) Combined interior & lighting solution

LIGHTING GROUP
P1) Regular classroom
P2) Regular classroom
P3) New lighting solution
P4) Regular classroom
P5) Combined interior & lighting solution

CONTROL GROUP
P1) Regular classroom
P2) Regular classroom
P3) Regular classroom
P4) Regular classroom
P5) Regular classroom

QUALITATIVE RESULTS

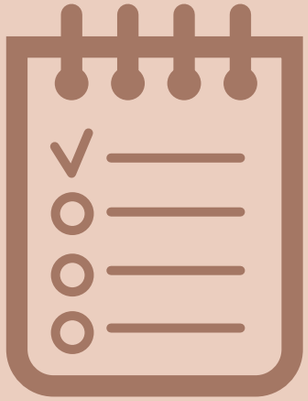


TEACHER LOG

ORGANISATION OF TEACHING AND LEARNING ACTIVITIES

- Teaching organisation varied considerably between teachers and was strongly influenced by lesson content and learning objectives.
- Communication and critical thinking were the most consistently represented competencies throughout the school year, while collaboration and creativity varied more depending on the activity.
- When the full classroom concept was introduced (P5), several teachers shifted away from whole-class instruction towards more student-centred learning formats.
- Group work and pair work with teacher support increased in several classrooms, creating more opportunities for communication and collaboration.
- Individual work with teacher support also increased, allowing teachers to spend more time with students during learning activities.
- In many cases, teaching became concentrated around fewer but more learner-active instructional formats.
- Traditional teacher-led whole-class instruction decreased for several teachers, although this pattern was not consistent across all classrooms.
- The intervention did not lead to one common teaching model; teachers used the environment differently depending on their pedagogical preferences and classroom context.
- The strongest changes were seen among teachers who adopted more group-based and supported student work, while others retained a more teacher-led approach.

  Overall, the learning environment appeared to create more favourable conditions for student-active learning without dictating a specific pedagogical approach.



STUDENTS OPEN-END COMMENTS IN THE SURVEY

STUDENT SURVEY COMMENTS INTERIOR

Students were given the opportunity to add open-ended comments to their responses to the closed-ended survey questions. The comments provide further insight into how students experienced the new classroom interior.

"It feels much better to sit now. My back no longer hurts."

"I can focus better now that the chairs are more comfortable."

"I like that we have more options for where to sit."

"It is easier to concentrate when you can move on the chair."

"The room feels more modern and comfortable."

"The classroom interior is very pleasant and makes me happy."

"It still feels new and exciting. You almost look forward to these lessons."

STUDENT SURVEY COMMENTS INTERIOR

KEY INSIGHTS

- **COMFORT** The new furniture was described as more comfortable and ergonomic.
- **FOCUS** Several students connected improved sitting comfort with better concentration.
- **FLEXIBILITY** Greater flexibility and freedom of choice
- **ATMOSPHERE** The classroom was perceived as more modern, welcoming and social.
- **ENGAGEMENT** Some students expressed greater enthusiasm about attending lessons in the new environment.
- **ACTIVITY FIT** Different seating options support different learning activities. Student awareness on how different furniture settings support different activities

STUDENT SURVEY COMMENTS LIGHTING

Students were given the opportunity to add open-ended comments to their responses to the closed-ended survey questions. The comments provide further insight into how students experienced the new classroom interior.

"I no longer get as many headaches after long lessons."

"I don't get headaches anymore, which is really nice!"

"The room feels brighter with the new lighting, and it looks more spacious."

"The different lighting settings make it easier to focus on different activities because they are less distracting."

"The lighting creates a calm atmosphere, which makes it feel better to be in the classroom."

"The new lighting doesn't glare in your eyes like the old one did, and it has a warmer tone. It helps me stay focused during lessons and maintain my energy levels throughout the day."

STUDENT SURVEY COMMENTS LIGHTING

KEY INSIGHTS

- **LIGHT COMFORT** The new lighting was perceived as softer, warmer, and more comfortable.
- **WELL-BEING** Students reported fewer headaches, less eye strain, and reduced fatigue
- **FOCUS** Improved lighting conditions supported concentration and sustained attention.
- **ATMOSPHERE** The classroom was perceived as calmer, brighter, more spacious, and more inviting.
- **ADAPTABILITY** Different lighting scenes supported different learning activities.
- **ENERGY** Students associated the new lighting with improved energy levels during lessons.
- **LIGHTING AWARENESS** Students developed greater awareness of how lighting affects learning and well-being.


The mind is like a parachute, works best when open
Den öde ön
DEN OSYNLIGE

TEACHERS' EXPERIENCES

FROM THE INTERVIEWS

LIGHTING

TEACHERS LINKED LIGHTING TO FOCUS, COMFORT AND ENERGY LEVEL

It’s as if the lighting drains their energy.
It’s almost as though they have to keep their eyes wide open, and after a while they just think,
‘This is exhausting.’
They struggle to regulate their energy levels, and once that energy is gone, it’s gone. At that point, they can no longer work or concentrate effectively.

Theacher before lighting intervention

ADAPTIVE LIGHTING WAS PRECIEVED TO IMPROVE FOCUS, COMFORT, ENERGY LEVEL AND WELLBEING

ATMOSPHERE AND WELLBEING

- Classrooms were perceived as calmer, more comfortable, and more inviting.
- Students seemed happier and more alert.
- Complaints about headaches and requests to switch off the lights largely disappeared.
- Some teachers felt that the impact of the lighting was greater than they initially realised.

COMFORT

- Complaints about glare and visual discomfort almost disappeared completely.
- The light was described as warmer, softer, and more pleasant.
- Students appeared more comfortable when presenting in front of the class.

TEACHERS MOVED FROM SIMPLE ON/OFF CONTROL TO PURPOSEFUL USE OF LIGHTING SCENES.

FOCUS AND ENDURANCE

- Teachers felt the previous lighting drained students' energy and made them tired more quickly.
- With the new lighting, students appeared to:
  - maintain focus for longer
  - sustain attention during extended lessons
  - require fewer breaks
  - cope better with 80-minute class sessions.
- Students with additional learning needs, including neurodivergent students, seemed able to concentrate for longer periods.

A PEDAGOGICAL TOOL

- Teachers actively began using different lighting scenes to support instruction.
- Lighting was used to:
  - signal transitions between activities
  - create either energy or calm,
  - adapt the environment for presentations, group work and film viewing

THE INTERIOR SOLUTION ENABLED MORE ADAPTABLE TEACHING

"I think it is a creative classroom. It encourages collaboration and supports a variety of learning activities, such as reading in groups, reading aloud, discussions, independent study, writing, and even finding a comfortable space to relax and focus. "

Theacher after interior intervention

THE INTERIOR SOLUTION ENABLED MORE ADAPTABLE TEACHING

TEACHING AND LEARNING ACTIVITIES

- The flexible furniture made it easier to adapt the classroom for different learning activities
- Teachers reported clear improvements for:
  -collaborative work,
  - discussions,
  - reading activities,
  - creative tasks,
  - individual support
- The layout encouraged more student-centred and active learning approaches.

FLEXIBILITY

- The room supported a wider variety of teaching approaches without rearrangements.
- Mobile furniture and height-adjustable desks made reconfiguration quick and easy when needed.
- Students started adapting the layout themselves according to the activity.

TEACHER-STUDENT INTERACTION BECAME EASIER

"There are many possibilities in terms of easier movement. Students are no longer as fixed in one place; instead, both the students and I can simply take a chair and move around. You can sit down with one group for a while to talk, and then move on to the next group. Communication has definitely become easier as a result."

Theacher after interior intervention

TEACHER-STUDENT INTERACTION BECAME EASIER

- The intervention classroom encouraged more informal and spontaneous interactions between teachers and students. Several teachers felt they had become “closer to the group.
- Teachers reported that the classroom design improved mobility, allowing them to move freely around the room, reach more students, and provide more individualised support.

MOVE

Teachers could move freely instead of remaining at the front.

SEE

Students were more visible throughout the classroom.

SUPPORT

Teachers could sit beside groups and individuals naturally.

CONNECT

The less formal layout encouraged spontaneous conversations.

COMFORT SUSTAINED STUDENT FOCUS

Improved seating and movement options supported concentration during demanding lessons.

ERGONOMIC SUPPORT

- Improved seating comfort was one of the most frequently mentioned benefits.
  Complaints about back pain, uncomfortable seating & physical discomfort largely disappeared.
- Height-adjustable desks and varied seating options were particularly appreciated and supported individual needs.
- Sitting and standing options enabled position changes
- High-backed sofas offered lower-stimulation spaces.

FOCUS AND LEARNING CONDITIONS

- Teachers reported improved concentration and reduced restlessness.
- Students:
  - requested fewer movement breaks,
  - remained focused for longer,
  - coped better with exams and late-afternoon lessons.
- The ability to change posture or seating position helped students maintain attention.

“For the students, the difference is like night and day compared to last autumn when I still had the old furniture. Back then, getting through a 70-minute lesson could be quite a challenge and required a great deal of creativity. So, absolutely, even if the students are not always full of energy, the situation is much, much better now.”

COMFORT SUSTAINED STUDENT FOCUS

Improved seating and movement options supported concentration during demanding lessons.

ATMOSPHERE AND WELLBEING

- The classroom was described as calmer, more pleasant, and more welcoming.
- Teachers observed that students:
  - arrived earlier for lessons,
  - preferred staying in the classroom during breaks,
  - consistently chose the redesigned classroom over other rooms.
- Teachers themselves also enjoyed spending time in the new environment.

ACOUSTICS

- Noise levels improved significantly.

- oft materials and wheeled chairs reduced scraping sounds and distractions.
- Especially group work became easier to manage without disruptive noise.

"It is so spacious and pleasant in there; it feels twice as large as a regular classroom. So it's a really good way to make use of the space."

"You are simply in a better mood, and that benefits learning. You can tell that the students are happier. They very rarely want to move to another classroom now."

CHALLENGES IDENTIFIED BY TEACHERS

Not all aspects of the intervention were equally beneficial. The redesigne introduced new possibilities, but also required teachers to adapt classroom management, furniture layout and activity planning.

- Whole-class instruction could sometimes be more challenging when students sat closer together.
- Some students needed to turn around to maintain visual contact with the teacher.
- Tests and exams required more planning and furniture rearrangement.
- The novelty of the furniture was initially distracting for some students.
- Daylight-compensating luminaires could be perceived as overly bright by students seated nearby.

WORKING DIFFERENTLY IN THE SAME PEDAGOGY

- Teachers generally did not describe changing w*hat* they taught, but rather *how* they could organise activities.
- Teachers discovered new ways of using planned assignments, for example turning different table groups into editorial teams during newspaper projects.
- The intervention broadened teachers' options without requiring a fundamental change in teaching philosophy or curriculum delivery.

LEARNING HOW TO USE THE ENVIRONMENT

- Both teachers and students required an adjustment period to become familiar with the new environment.
- Initially, students explored the furniture and tested its possibilities, which teachers sometimes experienced as disruptive.
- As the novelty effect faded, students became more intentional in how they used different furniture types and work zones.
- Sofas attracted considerable attention at first, but over time students learned which settings worked best for different tasks.
- Benefits became more apparent as teachers and students gained experience and developed new habits around the space.
- Students developed an awareness of how lighting and interior design could support learning
- Students actively selected and used different learning settings, furniture and lighting conditions to support their own work.

"I have some colleagues who say, 'Oh, I could never work with furniture like that.' But I think most of them actually could. They probably just need guidance and advice, as well as opportunities to practise. And they need to recognise that it takes time to become confident and proficient in using it. In the end its totally worth it"

ADVICE FOR SUCCESS

The benefits became clearer as teachers and students learned how to use the space purposefully.

ALLOW TIME

Become familiar with the environment.

SET ROUTINES

Create clear expectations.

MATCH THE ACTIVITY

Encourage apadtation to different learning tasks.

BUILD CONFIDENCE

Provide guidance, practice and teacher support.

IMPLICATIONS FOR DESIGN AND IMPLEMENTATION

IMPLICATIONS

- Students reported improved focus in the redesigned learning environment. And teacher interviews confirmed that this was clearly noticed.
- According to teachers, the environment supported innovative pedagogical practices, although it did not in itself lead to pedagogical change.
- Together, the interventions created better conditions for communication, collaboration, creativity, and personalised learning. However, teachers emphasised that the environment alone does not change pedagogy. Effective use requires time, practice, and conscious adaptation of teaching methods.
- Lighting primarily improved focus, energy levels, endurance, and classroom atmosphere.
- Furniture and interior design had the greatest impact on how teaching could be organised and delivered.

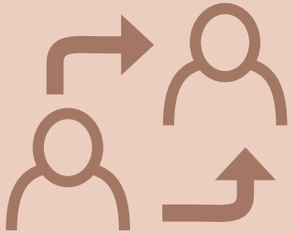
Overall conclusion

The results indicate that the combination of varied interior design solutions and adaptable lighting can create more user-friendly learning environments by enhancing focus, well-being, and the ability to tailor teaching to different activities and needs.

IMPLEMENTATION INSIGHTS

SECURE THE FUNDAMENTALS

Lighting, ergonomics and acoustics are direct factors for focus, endurance and calm.



PLAN FOR REAL FLEXIBILITY

Enable variation and reconfiguration without overcrowding classrooms. The ability to easily reach and engage with one another facilitates improved teacher-student interaction.

SUPPORT THE TRANSITION

Combine investment with user involvement, adaptation time, peer learning and intuitive systems.

TAKE A HOLISTIC APPROACH

The greatest benefits are achieved when lighting, interior design, pedagogical organisation, and teaching practice work together and are mutually aligned.