An investigation into how the application of performance lighting design techniques could enhance learning experiences within primary school classrooms

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1.0 Abstract

A parallel can be drawn between the classroom and the stage. The teacher, our main actor, delivers a performance to the audience of students, using their lesson plan as a script. The pupils must be engaged by various plot points to successfully reach the final act, and the conclusion of that learning experience. This analogy is the starting point for this investigation, which questions whether the classroom learning experience might be enhanced and improved with the use of performance lighting design.

Analysis conducted into various existing issues of classroom lighting design indicates that ill-considered lighting can lead to a lack of student engagement and teacher disempowerment. In combination with research into performance lighting design techniques, this forms a foundation for assessments of various case studies. The characteristics of these schemes are considered for how they impact the psychophysical state of the users, within that specific environment, for the delivery of its intended purpose. This study aims to outline a proposal design solution, for how theatrical lighting techniques could be utilised as a key tool in future educational settings, to enhance student experiences, and increase overall user engagement.

This will inform my base research for a proposal design of a new performing arts centre, featuring creative educational spaces. It is crucial to understand how light can be enhanced and edited, to change the user experience and perception of their environment, in order to design spaces appropriate for the intended users and the functions occurring within them. This study will add to the documented recognition of lighting as a key design tool; one that should be more carefully considered and employed within the industry of Interior Architecture and Design.

Contents

2.0 Introduction

Education, in its broadest sense, should not be distilled to simply the act of teaching and learning. Classrooms are also spaces which play a formative part in a young person's journey of self-discovery. They should provide a supportive setting for study, counsel, community, and self-expression. As evidenced in the *School Design Matters* report, the atmosphere of classrooms in many existing schools is arguably flawed, providing insufficient visual stimulation and sensory support for the varied activities taking place (Daniels, Stables, Tse and Cox, n.d.). Light is a fundamental element of interior design and has capabilities to induce psychophysiological responses and emotional reactions from perceivers (Tomassoni, Galetta and Treglia, 2015).

2.1 The importance of primary schools

> *"A school is not simply a shell of designated dimensions containing students and teachers but an important design opportunity to support the social structure of school communities in one of the most vital spaces for youth and those who work with them."*
>
> *– (Daniels, Stables, Tse and Cox, n.d.)*

The provision of the best education for children is a key societal goal (Barrett, Davies, Zhang and Barrett, 2015) and needs constant revision, especially within this rapidly developing technological era.

A learning environment can be defined as any space, in or out of the traditional classroom, which encompasses not only the teaching that occurs, but also the culture of a school or class (Learning Environment Definition, 2020). These spaces have both direct and indirect impacts on the students and staff who operate within them, and therefore any design issues, such as inadequate lighting, should be corrected (Learning Environment Definition, 2020).

This study will refer specifically to learning environments and classrooms within primary schools. Children from ages 4-11 will attend a primary school, progressing through Key Stages 1 (KS1) and 2 (KS2) over a period of eight years. The decision to focus on this particular school setting was motivated by the fact that children will spend the majority of their time within one classroom (Barrett, Davies, Zhang and Barrett, 2015).

Furthermore, children of this age require not only a place of education, but also the opportunity to build social skills, and explore various interests which they may later develop outside the classroom (Thomsen, 2014). A good classroom is, therefore, key to supporting personal growth and self-expression.

The number of primary school students has risen year on year, with the 2020 count totalling 4.71 million in England (School capacity, Academic Year 2018/19, 2020). 20% of primary schools were at, or exceeding their capacity, with an average class size of 26.9 pupils in KS1, and 27.9 in KS2 (School capacity, Academic Year 2018/19, 2020). In order to keep pace with need, 15 new primary schools were established between 2019-2020 in England (Schools, pupils and their characteristics, Academic Year 2019/20, 2020). The data indicates a clear need for both development of new schools and expansive redesign of existing schools, to meet future demand.

2.2 The significance of performance lighting design

Lighting design as a specialism is expanding and growing in significance within the broader interior design profession (Moran, 2019).

Performance lighting involves the skilful manipulation of light for dramatic effect (Moran, 2019). Successful lighting schemes have the capability to influence the viewer's cognitive, emotional, and behavioural responses (Tomassoni, Galetta and Treglia, 2015).

Performance lighting designers use light, in a variety of carefully choreographed formats, to create psychological or dramaturgical effects. Shadows can represent the passage of time, Colour signifies emotions and mimics nature, and the use of profiles can isolate performers, or a flood of light can unite the cast (Moran, 2019).

> *"The competent performance lighting designer, working with the right tools, can truly 'write the stage' as a scenographer." (Moran, 2019)*

It is widely accepted that well-designed performance lighting has the capability to "enhance the communication between performers and their collaborators" (Moran, 2019). Such enhancements could be similarly applied in educational settings to improve communication between teachers and pupils.

3.0 Literature review

3.1 Performance Lighting Design

Moran, N., 2019. *Performance Lighting Design*. 2nd ed. Bloomsbury Publishing Plc.

One of the key pieces of literature referred to throughout this study is Performance Lighting Design. Written by Nick Moran, an experienced lighting designer, active researcher and lecturer at London's Central School of Speech and Drama. This combination of expertise and experience qualifies him to write in depth on the subject of performance lighting.

This book provided details of performance lighting design technique, how to achieve various effects, and their possible impact on an audience. Critically, this source provided knowledge of the five key properties of light; namely beam, focus, intensity, colour, and timing. These properties have been referenced throughout the investigation, and each one has been analysed in reference to key case studies, in order to determine their spatial impacts, and how they could best be applied to educational settings.

In addition, this book provided the scientific basis for explaining what light is, and how it is perceived, referenced in Chapter 4.1.

3.3 Psychology of Light

Tomassoni, R., Galetta, G., & Treglia, E. (2015). Psychology of Light: How Light Influences the Health and Psyche. Psychology

Another key source referenced in this essay is the "Psychology of Light: How Light Influences the Health and Psyche". This investigative journal explains the psychophysical impacts of light on people's wellbeing, as well as how light forms our general perception of the world. The authors, a collective of psychologists from the University of Cassino and Southern Latio in Italy, propose the idea that light creates a cognitive map, from which humans learn to understand and interpret the environment around them. This perception can be manipulated through the alteration of factors such as light intensity and light colour.

They assert that light stimuli to have the ability to impact people in three ways: induce specific emotions, influence bodily and mental health factors, and act as a source of aesthetic pleasure or environmental enjoyment. The writers also expand on how light deprivation, and intensely persistent light, will detrimentally affect people, as proven by the fact that historically light was used in these most extreme formats, as a torture device.

This journal has informed the psychological understanding that underpins the judgements made of the various case studies in this investigation. The evidence in their findings support the argument that light is a crucial interior design tool, which can significantly impact the wellbeing and psyche of people within a space.

3.4 The impact of indoor lighting on students' performance in learning environments

Samani, S., 2012. The impact of indoor lighting on students' learning performance in learning environments: A knowledge internalization perspective. *International Journal of Business and Social Science*

This was one of the key sources that referenced the significance of light, specifically in regard to the design of schools. This study was conducted to investigate the influence of lighting on students' learning performance. The author, PhD student Sanaz Samani, analysed numerous literatures and reviewed psychological impacts and evidence that suggests light can alter students' performance and mood when in classroom environments.

Moreover, it was indicated how perhaps different subjects should be individually assessed for lighting requirements. This is crucial to note as, within this study focussed on primary school classrooms, a variety of subjects take place within the same single classroom. Therefore, any future proposal scheme needs to accommodate a variety of tasks within one space, supporting the argument for adaptable active lighting.

In addition, Samani cited Veitch and Newsham's six considerations of a successful lighting scheme:

1. Visual performance
2. Post-visual performance
3. Communication and social interaction
4. Mood state
5. Aesthetic judgments
6. Safety and health

These six considerations form a judgment criterion from which the case studies and relevant research within this dissertation have been assessed. This will lead to a justified proposal of specific techniques and considerations that should be more commonly implemented in the design of future classrooms.

4.0 The importance of light

4.1 What is light

"Everything we see, we see because light, emitted or reflected from objects enters our eyes and forms images there on the retina" (Moran, 2019).

In order to develop a deeper understanding of light and its potential impact, it is crucial to first acknowledge the science behind it.

Certain wavelengths within the electromagnetic spectrum are visible to the human eye. Each correlate to a colour, visible when the light is emitted or reflected from an object (Moran, 2019). White light is the combination of all wavelengths, from which some will be absorbed, and others reflected allowing the eye to interpret the colour of what is being seen.

Light has an impact on human function and well-being, since it regulates our circadian rhythms and associated bodily functions, such as immune response, hormone levels and sleep patterns (SSL-erate, 2020). Light also has an impact on mood, alertness, and attention levels (SSL-erate, 2020).

This demonstrates how light is responsible for shaping and colouring our environment and, as a result, when manipulated by lighting designers, can drastically alter a person's interpretation of their surroundings, and consequently alter their psychological and emotional state (Tomassoni, Galetta and Treglia, 2015). It is reasonable to assume that if lighting is designed to create the best learning experience, it would result in increased productivity and positivity from pupils and staff.

4.2 The properties of light

The properties of light, as defined by Moran, are intensity, beam, focus, colour, and timing. These are alterable aspects which can be used by lighting designers to create various effects (Moran, 2019).

Intensity: How much light is present

Focus: the source of the light and where it lands

Beam: the direction and visibility of the light as it travels

Colour: can be edited with application of gels or lenses

Timing: the ever present fifth element, can unite all the properties into a cohesive lighting scheme

These properties will be discussed collectively and individually. They provide points to analyse within the lighting schemes of the various case studies in subsequent chapters.

5.0 The role of light in schools – The current issues

Light has various influences within a space; “visibility, task performance, communication and social behaviours, health and safety, mood and comfort, aesthetic and judgements” (Moran, 2019). Analysis was conducted into current school design, in order to establish the appropriate lighting solutions to best support these various roles. This was primarily based on research from teaching blogs, background information within academic studies referenced in this investigation, and observation. These issues will also have relevance beyond school settings.

Issue 1: Glare and Technology

Glare is the intensified reflection of light upon a surface which creates discomfort for the perceiver (Moran, 2019). This can be caused intentionally or unintentionally, and in extreme cases, can cause physical pain (Moran, 2019). A study by Winterbottom & Wilkins, cited by Mott, found flicker from fluorescent lighting present in 80% of 90 UK schools observed (Mott et al., 2012). The conclusion was that the majority of classrooms have “an unnecessarily inefficient form of fluorescent lighting that has been shown to cause headache and impair visual performance” (Mott et al., 2012).

Technology common in classrooms is also susceptible to glare. Interactive whiteboards with inappropriate lighting can be difficult for every pupil to observe comfortably. Pupils are required to look between various surfaces, papers, and screens. This repetitive “heads-up, heads-down” makes it harder for vision to adapt fully to observing one format in particular (Samani, 2012). The visual transition between activities is an aspect which should be resolved in future lighting schemes.

Issue 2: Daylight versus artificial light

An investigative report by the Heschong Mahone Group found that classrooms with the most daylight resulted in 20-26% faster learning rates, as shown through test scores of the pupils (Heschong Mahone Group, 1999). Light can be discussed in terms of quality, referring specifically to the “brightness contrast, potential for glare and colour renders” (Altan and Zhang., 2018).

Natural light is the best source in terms of light quality (Altan, H. and Zhang, Y., 2018) and furthermore, people express preference towards having natural light in working environments. However, this could be interpreted as a desire to work near a window (Altan, H. and Zhang, Y., 2018) not purely motivated by the need for light but, perhaps, a preference for a view. For those with window views, there is an associated increase in social status. More senior teachers may believe they deserve the perceptively better classrooms (Heschong Mahone Group, 1999).

However, windows can also cause problems, including indirect glare and casting of shadows during different times of the day. The study by Altan and Zhang explained how large window workplaces commonly featured blinds, which, during sunny seasons, or particular activities, would be closed. They observed that the blinds would commonly then remain closed, and workers revert to the overuse of artificial lighting instead (Altan, H. and Zhang, Y., 2018). This demonstrates the need for artificial lighting schemes to provide the fundamental basis of lighting support within spaces where windows will be covered. The questionable reliability of sufficient amounts of daylight is also a notable reason why lights should be appropriately utilised in learning environments.

Issue 3: Time management

One educational blog detailed time management as a particular challenge facing teachers. Across the day, they shoulder multiple roles, from tutor and counsellor, to organiser and planner (2020's Top 21 Classroom Challenges, According to Teachers, 2020). The classroom should be designed to aid the teacher in each of these important functions.

Teachers are held accountable for the academic progression of the class and discipline (2020's Top 21 Classroom Challenges, According to Teachers, 2020). However, evidence shows that the environment in which learning is conducted has a significant impact on the behaviour, and consequent academic productivity, of pupils (Thomsen, 2014). The role of the room is, arguably, underestimated by educators, designers, and Ofsted.

Light could be utilised as a tool for timing and structuring the day. This is further explored in the proposal design solutions for future classrooms.

Issue 4: Task lighting

The lack of task-specific lighting within primary school classrooms is relevant, since younger pupils have a variety of subjects taught within the same space (Barrett, Davies, Zhang and Barrett, 2015). Being situated continuously in the same environment may result in the various subjects chronologically merging and consequently lacking individual focus.

Light requirements of common classroom activities vary greatly. Reading requires a level of light for visibility that would perhaps not be accommodating of a teacher presentation utilising the interactive whiteboard. Ambience and relative intensity of light could accommodate subject specific activity, and also induce an appropriate atmosphere suited to the subject being taught. For example, cool, blue hue light has been found to be suited to more focused tasks, whereas warm light is more beneficial to relaxed tasks such as reading or social time (Mott et al., 2012). The creation of these appropriate lighting schemes and the transitions between them, should be a focus issue solved by the proposal design solution.

6.0 Case studies

The following case studies were selected for their notable use of lighting techniques to enhance the performance taking place, and to underline the premise that such techniques may be employed in an education setting. Various highlighted aspects of lighting will be further analysed in chapter 7, to illustrate how similar techniques might be used in schools.

6.1 Hamilton

Hamilton. 2020. [film] Directed by T. Kail. Richard Rogers Theatre, New York, USA: Walt Disney Pictures (Disney+).

The Broadway musical Hamilton, directed by Thomas Kail, received a record 16 Tony Award nominations, including best lighting in 2016 (L. Travis, 2017). Lighting designer Howell Binkley, and lighting programmer David Arch, collaborated to create a unique lighting scheme, appropriate for this unorthodox retelling (Harman, 2016). Hamilton uses a hip-hop style and lyrics, unusual in musical theatre, to portray the historic story of the American revolution from the perspective of the Founding Fathers. By modernising this portrayal of history, it has arguably made the story more accessible and entertaining for 21st century audiences.

The lighting scheme for the show also breaks with traditional techniques, notably, with the use of an exposed lower lighting rig (Harman, 2016). This gives performances a 'rap concert' aesthetic and is intentionally visually juxtaposed with the more traditional and historically accurate set and costumes (Harman, 2016). The scheme made use of profiles (spotlights) to highlight key characters within a scene. Colour was utilised to create a sense of the passage of time and to add atmosphere and mood. When all combined, in conjunction with the rhythmic timing of the lyrical score, it results in a dramatic, engaging visual spectacle.

Figure 1. Hamilton, The Schyler sisters

The incredibly popular production was accompanied by a movement within education. The EduHam programme was launched in 2016, with the aim of both exposing younger generations to the performing arts and inspiring an interest in history and culture.

> *"Hamilton is a jumping off point for them to engage with history on a deeper level"*
>
> *- Lin-Manuel Miranda in interview with Robin Roberts, Hamilton: History Has Its Eyes On You*

This theatrical interpretation prompted broad discussion and re-evaluation of a pivotal period in American history. Under-represented perspectives, such as those of women and people of colour, were brought to the fore. This is especially prevalent during such politically turbulent times as in 2020, with the rise of the Black Lives Matter movement and debates about politics becoming more common in public settings. A similar, evidently engaging, method of portraying information could be applied to the teaching of other historical stories, as well as other subjects in schools, if classrooms and applied lighting schemes are made able to accommodate such activity.

The limitation of this case study is in the fact that the referenced performance of the Broadway musical is a recorded version accessible on film streaming service Disney+. Although the lighting storyline, scenography and lighting effects have been maintained and are still clearly visible, it is possible that some of the overall impact of the performance cannot be transmitted through a screen.

6.2 Dynamic Lighting classrooms, Herstedlund school, Denmark

Zumtobel, 2019. *Dynamic Lighting In Classrooms: A New Interactive Tool For Teaching*. [online] Available at: <https://www.zumtobel.com/media/downloads/Study_DynamicLighting_EN.pdf> [Accessed 18 November 2020].

This case study concerns the application and review of a prototype active lighting system, which was installed in Herstedlund school in Denmark, by Zumtobel. The study was conducted over a period of three months in 2019, when four classes with the newly-applied lighting scheme were observed.

The active lighting scheme had four pre-set scenarios: standard (fig.02), white-board, fresh and relax (figure 3). “It was hypothesised that the scenarios would help the teacher to structure their teaching” (Zumtobel, 2019). Data was collected from system usage logs, detailing which of the scenarios was most utilised and when.

The study found five main motivations for a teacher to interact with and alter the lighting of the classroom:

- They are supporting and structuring the learning
- They are communicating to the students with light
- They are supporting visual tasks & ensuring visual comfort
- Influencing the activity level
- Creating a particular mood/atmosphere

The study concluded there was merit in the design prototype. The success of the adaptive lighting scheme could be gauged by both the choices of the teacher, and the engagement of students, who became involved in selecting the lighting environment to suit their changing needs.

It also observed that teachers often utilised manual settings, in order to edit and create completely new schemes, to suit different times of year, and different, subject-specific, activities. This gives ground to the argument that there is need for further refinement and a broader variety of pre-set scenarios from which to choose.

Overall, this case study supports the assertion that lighting in schools could be better managed, with systems to allow tailoring of light for atmosphere, intensity and accommodating a variety of activities.

Figure 2

Figure 3

7.0 Applications of performance lighting in schools – Proposal solutions

7.1 Light intensity as a tool to create social order and daily structure

Time management, as highlighted in chapter 4.2, is an issue for teachers (2020's Top 21 Classroom Challenges, According to Teachers, 2020). Utilising light, of varying intensity, may add structure to the school day; providing timers, subtle cues, and pre-set changes, aligned with the daily lesson plan. Automation of a lighting system, similar to that in the Zumtobel case study, could become an integral feature of future classrooms. Light alteration might cue subject changes, or prompt break times; intervals, assisting the teacher with time management.

Lighting could signal to pupils that a lesson is starting or ending. Before a theatrical performance, house lights are dimmed, bringing focus to the illuminated stage area, and signalling that the audience should settle (Moran, 2019). Replicating this expectation and response in the classroom could be of benefit to teachers, as an unspoken instruction to pupils that it is time to concentrate.

Fluctuating light intensity, prompts an increase in alertness and response speed (Tomassoni, Galetta and Treglia, 2015). Use of flashing lighting, to guide the actions of the public, is already common in emergency alarm signals. Editing light intensity, to indicate a desired action, could be another subtle cue to pupils that their attention is required.

Indicative lighting with increasing intensity is often used in public speaking situations, another form of staged performance. In televised debates, politicians may have a light in their line of sight. Red flashing indicates they are reaching the end of their allotted time. It stays lit when that time is up, such as in figure 4 (NBC News, 2016). A similar lighting tool could be applied to classroom discussion activities, to encourage contributors to be concise, and assist with time management. It might also assist with time-limited tasks, such as examinations.

Figure 4. US presidential debate, 2016

7.2 Directing focus within the classroom

As explained by Moran, light can aid direction of focus within a space, since our attention can be directed by even subtle changes in the relative intensity of light (Moran, 2019). Human sight has evolved so that peripheral vision is attuned to detect movement, while the central field of vision has the ability to observe the most detail. At the commencement of a performance, the house lights will be dimmed. This directs focus towards the stage, intentionally located within the audiences' central field of vision (Moran, 2019).

Throughout a performance, various sources of light can also be used to draw attention to a specific actor, or area within the performance space. Figure 5 portrays a clear use of profile lights to create a visual hierarchy amongst the performing characters in this scene from Hamilton. The main actor has the brightest follow spot, whilst secondaries are in dimmer light. This leaves ensemble, background dancers, illuminated by the overall stage light wash provided by the large Fresnel lights, visible in the lighting rig, and coloured uplighters around the edge of the set. A simpler hierarchical lighting system could be used to direct focus towards a teacher during lessons.

Specials are also used to direct focus to a specific space within the performance area. Figure 6 demonstrates how, in the production of Hamilton, the light illuminated only a circle, centre stage. The creation of space within space could be applied to classrooms. One study into the requirements of primary school classrooms, highlighted the need for activity centres to allow children to engage in focused, independent study (Thomsen, 2014). Lighting could be applied to isolate and theme these focus activity centres. Reading areas, for example, would benefit from warmer lighting tones, that support the visual requirement while also creating a comfortable atmosphere, suitable for quiet informal activity, as suggested by the conclusive study into the effects of lighting on students' oral reading fluency, conducted by Mott (Mott et al., 2012).

The current natural focal point in many UK classrooms is the interactive whiteboard. This large screen is vulnerable to glare from windows and surrounding bright lights. It would therefore be appropriate to lower the lighting level of the classroom whenever the screen is in use (Zumtobel, 2019). The pre-set whiteboard lighting in the Zumtobel case study was effective and utilised by all the teachers (Zumtobel, 2019), indicating that it would be a useful setting to include in future school lighting schemes. Additional pre-sets for various subjects and activities could also be beneficial for the variety of teacher and pupil activities within the space.

Figure 5. Hamilton, Yorktown (The world turned upside down)

Figure 6. Hamilton, Cabinet Battle #2

7.3 Light to encourage self-expression and educational enjoyment

As stated in chapter 2.1, children in primary schools are at an age of great self-discovery and growth, which needs to be supported by their learning environment.

One study into the importance of classroom design stated a need for individualisation of the space, to create a sense of ownership of the classroom by children (Barrett, Davies, Zhang and Barrett, 2015). This is achieved currently through displays of pupils' work and, perhaps, personalized name tags on the desks or lockers. The desire for pupil involvement in the look of their classroom was further highlighted in the Zumtobel case study. It was observed that pupils wanted to have an active part on selecting the lighting pre-set used for their lessons (Zumtobel, 2019). This suggests that individual lighting elements, such as desk lamps, could be another way to provide a sense of ownership and personalisation, enhancing their classroom experience. Furthermore, this individualisation of the lighting scheme would provide motivation and amenity for self-teaching when appropriate, such as during independent reading time.

Drama is perhaps the obvious school subject where performance lighting comes into its own. Drama aids the development of reading, writing, and speaking skills. It is also a method for exploring culture and social behaviour, as documented in the report by the National Advisory Committee on Creative and Cultural Education (NACCCE), titled *All Our Futures: Creativity, Culture and Education.* The report argues for the integration of creativity and the acts of teaching and learning, with particular emphasis on deepening pupils' cultural understanding and appreciation (National Advisory Committee on Creative and Cultural Education, 1999).

This ethos is similarly evident in the EduHam programme, inspiring engagement in culture and national history. The programme provides pupils with primary historic sources and challenges them to interpret and perform the stories in a manner similar to that seen in *Hamilton*. The integration of complex educational sources with the fun methodology of drama has been shown to make learning both enjoyable and effective.

Lighting design, when considered together with spatial arrangement of a classroom, could assist such creative activity, better enabling proven teaching methods.

7.4 Coloured light as a tool to create emotive atmosphere

In lighting design terms, the colour of light can be edited, through addition to, or subtraction from, the visible wavelengths of light (white light). This is commonly achieved by applying gels or filters to a luminaire, which will absorb unnecessary wavelengths, and reflect the desired colour. This effect can be applied to multiple light sources at once, to create a colour wash, or light flood, over a performance area.

Colour is often utilised in performance to convey the emotional state of characters and can also influence the audience. This notion was investigated by McDaniel, through surveying audience members attending a performance of *Wit*. The conclusion was that the lighting did increase the audience's emotional connection to the content of the production, and their overall experience (McDaniel, 2018).

Colour psychology is an expanding field of research. It should be noted that colour connotation and symbolism vary within cultures: "Our emotional and intellectual response to colour is largely learned and therefore culturally specific" (Moran, 2019). This is an important consideration when discussing the application of colour to schools, since these spaces must be broadly accommodating of a range of cultures and ethnicities.

The technique of emotional enhancement could be applied to certain classroom activities, in order to increase engagement or enjoyment of the information being taught. During a science class about the water cycle, for example, the colour of the classroom could dramatically reflect the subject matter, manifesting in a blue or green illuminated space. This could aid pupils' knowledge conversion, with a memorable visual reference associated with the information they have gained.

The alteration of light's chromatic hue can also evoke tactile sensations of perceived temperature (Tomassoni, Galetta and Treglia, 2015), as well as psychological effects. Hospital waiting areas commonly feature low lighting with warm hues, to induce a sense of relaxation and welcoming hospitality. By contrast, in highly productive or competitive environments, such as corporate offices, colder blue tone light will more often be used, as it stimulates worker efficiency and productivity levels (Tomassoni, Galetta and Treglia, 2015). There will be times when a classroom environment should be lit to accommodate high productivity levels, but at other times it will be appropriate to relax the atmosphere to allow for sociable learning. A performance lighting design scheme would be adaptable to the many classroom scenarios and activities.

8.0 Conclusion

After considering issues of current classroom lighting design, together with the case studies outlined, it is apparent that improved lighting schemes would be beneficial in all classroom settings. Taking lighting improvements a stage further, by incorporating some of the techniques used to dramatic effect by performance lighting experts, could bring additional benefits.

The theatrical lighting case study, the musical *Hamilton*, utilises multiple lighting techniques to assist with communicating the historical narrative. Meanwhile the Zumtobel active lighting system proves there is merit to the proposal of replicating similar lighting schemes in schools, especially if enhancements are made, such as automation and expansion of the pre-set library.

Ideally, further research would combine both case studies and test the theory outlined in the proposal. Development of a prototype lighting system would be required, pushing the classroom lighting scheme toward the realm of production lighting. Qualitative and quantifiable data could be collected from surveys and usage logs, to determine to what extent the learning experience is improved.

In conclusion, light is the visual key to understanding our environment and the role which we play within it. In a classroom, an applied active lighting system, enhanced by performance lighting elements, could guide, emote, organise, and enhance the learning experience of future generations.

Rethinking our approach to classroom lighting could focus pupils' attention on lessons, help teachers' time management, and provide a new, unspoken yet obvious, form of communication in the classroom: let the lesson begin.

Word count: 4723 (excluding cited references, figures, quotes, titles, contents, and bibliography)

5200 including citations and chapter titles

9.0 Figures list

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