How does a storytelling intervention influence students' behaviour during a school overheating event

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Abstract: A new story, "The Hottest Day in School", was designed as a pre-heatwave intervention to enable children to have the confidence to change their behaviour in school, such as drinking more water during a heatwave. A control: intervention approach was taken for two schools, where 5 classes read the intervention story following an advanced high-temperature warning being issued. On the high-temperature day, researchers visited classes and asked children to complete a sticker task to reflect on "my day" and "my better day". 13 stickers were available to choose from including actions (such as removing clothing) and thermal comfort statements (such as too hot). Sticker diaries of children in the intervention classrooms show a higher frequency of stickers which reflect the heatwave messaging in the story than control classrooms. KS2 intervention classroom children were found to be twice as likely to select heatwave messaging stickers (chi-square test, p=0.03).

Keywords: overheating, pupil thermal comfort, storytelling intervention, schools

1. Introduction

Overheating in the UK buildings is now considered as a significant risk, especially in the school buildings. Post-war lightweight buildings predominate the existing school building stock in the UK, which are characterized by low thermal mass, over-glazing, and poor ventilation, contributing to low thermal performance, and making classrooms more susceptible to overheating in the summer (Teli, 2013). Uncomfortable classroom temperatures can lead to reduced academic performance, poor concentration, and disruption of classroom discipline, and in more severe cases can lead to health problems and even absenteeism (Wargocki and Wyon, 2007, Wargocki et. al., 2019).

An early study of the thermal comfort of 1300 students aged 7-11 years showed that children are more sensitive to high temperatures than adults, and as a result, their comfort temperatures are 2-3 degrees lower than those of adults (Teli et. al., 2012). The most common current methodology for assessing environmental thermal comfort is the Predicted Mean Vote (PMV) and the Predicted Percentage of Dissatisfied (PPD), which are primarily aimed at adults, derived from a laboratory setting, and are therefore thought to be underestimating

students' thermal discomfort (Teli, 2013). A behavioural survey of students found that students usually do not respond as expected when faced with high temperatures (Wargocki and Wyon, 2007). This is usually because they do not know what actions to take or are not confident in these behaviours. For example, they do not proactively remove their school jumper, which may be because they do not feel confident about adjusting their clothing in the classroom setting.

The aim of this project, via a control intervention study, was to use storytelling as a means of intervention to explain to students in the intervention group five actions that can be effective in improving indoor thermal comfort (remove clothing, drink cold water, stay in the shade, use a fan, open a window). The book would encourage students to initiate these actions through the practices of the storybook characters. A sticker task was used to collect information comparing the behaviours of the intervention and control groups when faced with a high-temperature period in school. This experiment was carried out with KS1 (5~7-year-olds) and KS2 (7~11-year-olds) age groups to see the extent to which this intervention had an impact on the different age groups.

2. Materials and methods

2.1 Intervention

This study was carried out in Hampshire, on the South coast of England with two schools near Southampton, with KS1 and KS2 age groups respectively. In the KS1 school, there was one intervention and one control group. In the KS2 school, there were three intervention groups and one control group. The intervention was a storybook entitled "The Hottest Day in School", which was designed specifically for the experiment, led by this paper's co-authors, Chater and Montzami. The story is based on a "history day", in which the protagonist imagines themselves to be a character in history and comes up with five different ways to cope with a heatwave: "The Fan", "The Jumper", "Moving to the Shade", "Opening the Window", "Find a Drink" (see Figure 1).

Figure 1. Storybook cover and the five action images mentioned in "The Hottest Day at School" storytelling intervention (a. Fan; b. Move to the Shade; c. Remove Clothing; d. Open Window; e. Drink Water)

Hampshire County Council issued a heat wave alert to Hampshire schools for Friday the 7th July on 5th July. KS1 and KS2 classes ran the activity on 5th July and 6th July. Children in both the control and intervention classes all received their own copy of the book to keep following the completion of the study. Informed consent from all pupils was obtained alongside

notification of parents of the activity and consent process (University of Southampton Ethics 81907).

2.2 Sticker task and data collection
On the day of the experiment, UoS researchers visited the schools and asked the students from both the intervention and control groups to complete a sticker task to record the students' behavioural changes when facing overheating in the classroom and their thermal comfort on the day of the experiment. A sticker task was chosen as previous work has shown this to be an excellent engagement method with schoolchildren (Teli, 2013).

The sticker task consisted of four questions: "My day", "My better day", "How I feel at the moment" and "How I wish I felt". Students were given 13 stickers (including 10 actions and 3 feelings) to describe their "My day" and "My better day", which included the 5 actions mentioned in the storybook. The sticker task also includes two 7-point LIKERT scales, in which students could choose a temperature sensation that best matched their feelings to describe "How I feel" and "How I wish I felt". An example, an anonymous completed sticker task is shown in Figure 2.
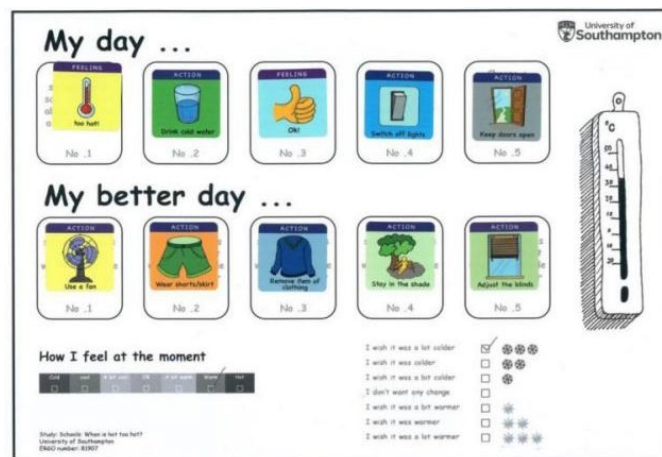

Figure 2. An example sticker task completed by a student.

During the time that the students were completing the sticker task, the researcher recorded information about the classroom and the students, including information about the amount of water the students drank, the number of times they used the fan, the clothing the students were wearing and any changes (e.g., jumper) and the number of windows that were open in the classroom.

Prior to the start of the experiment, the researchers commissioned and switched on the indoor temperature, RH, and CO_2 logger. The logger (Extech SD800) specification was as follows: temperature (resolution 0.1 ℃, accuracy ±0.8 ℃), RH (resolution 0.1 %, accuracy ±4%), CO_2 (resolution 1% ppm, accuracy ±40 ppm), recording data every 30 seconds to calculate classical thermal comfort values (Zhao et. al., 2021). A questionnaire was also administered to the teachers to obtain their reflections on how their students felt during the past year's heatwave periods.

3. Data analysis
The study collected a total of 82 control and 136 intervention students' responses, of which 22 intervention and 22 control students were KS1 and 114 intervention and 60 control students were KS2. This study used R Studio (Kronthaler and Zöllner, 2021) to analyze the students' votes on the 5 actions mentioned in the storybooks.

A Chi-square test was conducted on the data to analyse whether there was any significant difference between the intervention group and the control group regarding voting on each of the five actions. Due to the small amount of data, this project used Fisher's exact test to analyse the data (Larntz, 1978). When the calculated p-value is less than 0.05 this indicates that a significant difference between the data, i.e., the intervention had an impact on the students in the intervention group. In order to assess the impact, the project further performed an Odds Ratio (OR) calculation on the data. OR can be used to calculate how likely the intervention group is to make a choice on the action relative to the control group of students. As the voting data for this project were discrete, unordered variables, Cramer's V test was also used to analyse the correlation between actions to analyse whether students' choice of one action would influence the choice of another action (Cramér, 1999).

4. Result

4.1 Chi-square test

The Chi-square test and OR calculation results for KS1 and KS2 students are shown in Figure 3. KS1 students' p-values for six of the ten data items in the "My Day" and " My Better Day " voting on the five actions are less than 0.05, showing a significant difference between the intervention and control groups. It can be seen from the Chi-square test that, "Stay in the shade", "Remove clothing" and "Drink water" of "My Day" shows a significant difference between the intervention and control group.

The intervention group is 5 times more likely to choose "Stay in the shade" than the control group. "Stay in the shade", "Use fan" and "Drink water" of "My Better Day" also show significant differences between two groups. The intervention group is 11 times more likely to choose "Use fan" and 9 times more likely to choose "Drink water".

For KS2, 3 of the 10 actions show a significant difference between the intervention and control group. "Stay in the shade", "Use fan" and "Open window" of "My Day (MD_*)" shows a significant difference between the two groups. Amongst them, the intervention group is 2.4 times more likely to choose "Use fan" and 2.4 times more likely to choose "Open window". There were no significant differences between the two groups in "My Better Day (MBD_*)" in KS2.
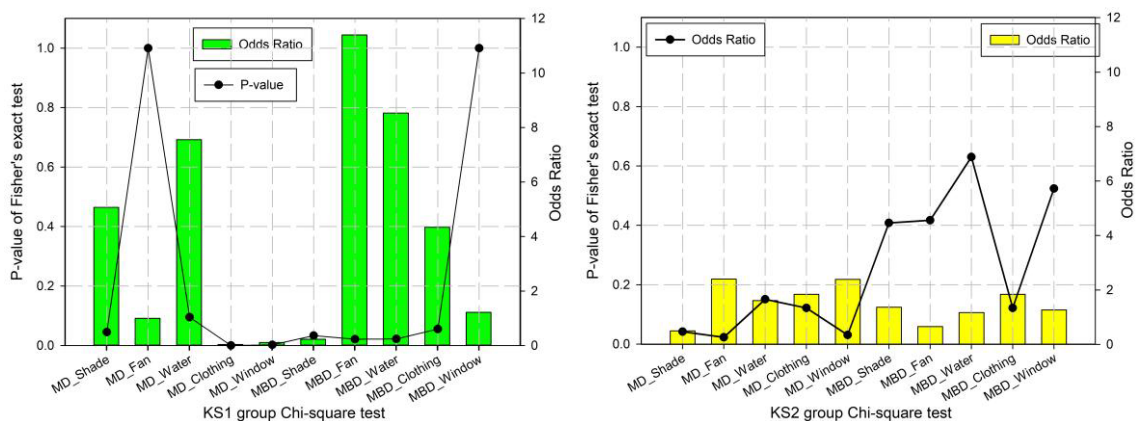

Figure 3. Fisher's exact test and Odds Ratio calculation of KS1 (left) and KS2 (right), (MD "My Day", MBD "My Better Day")

Students in the intervention group were seen to be more inclined to choose "Use a Fan", "Open window" and "Drink cold water" than students in the control group after the intervention. The students in the intervention group were more inclined to choose "Use a

Fan", "Open window" and "Drink cold water" after the intervention. The behavioral change of students towards "Remove Clothing" should be further investigated in a large scale of experiments in the future.

4.2 Correlation analysis

In Cramer's V test, a correlation of 0-0.09 is defined as "no relationship", 0.1-0.3 as "small effect", 0.3-0.5 as "medium effect", and above 0.5 as "large effect". In this study, both the intervention and control groups from KS1 showed medium correlations between the choices of 'Open the Window' and 'Use a Fan' in My Day. The intervention and control groups of KS1 also showed medium correlations between the choices "Drink cold water" and "Use a Fan" in My Better Day. This means that KS1 students performing one of these three behaviours may influence the performance of the other two.

4.3 Thermal comfort analysis

This study also collected students' thermal sensation vote (TSV) and thermal preference vote (TPV). The PMV and PPD models now used to measure thermal comfort are mainly calculated based on data from adults in a laboratory environment and therefore do not accurately measure students' thermal sensation (Teli, 2013). This study collected the temperature, and relative humidity and recorded the students' clothing during the experimental time. According to the CIBSE Thermal Comfort Tool, the PMV of the students in this classroom condition was "neutral" with PPD values ranging from 5% to 8% (CBE Thermal Comfort Tool, 2023).

However, the students' TSV and TPV results showed that at an ambient temperature of about 26.7 degrees, the students generally considered the temperature in the classroom to be "warm" and wanted to feel "colder". A comparison of the students' PMV calculations and the actual TSV is shown in Figure 4 below.
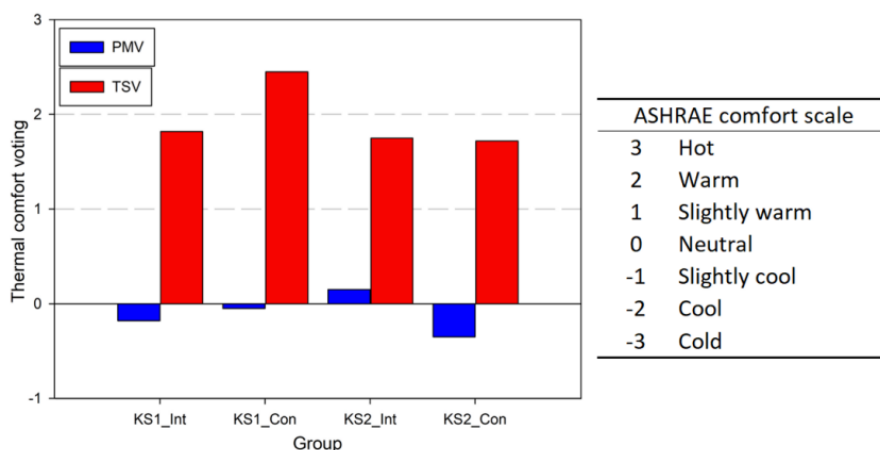

Figure 4. PMV result and students' TSV result comparison across 2 study schools, 7th July 2023.

As can be seen from the figure, students' level of thermal discomfort is much higher than that calculated by the PMV model, which indicates that students are indeed experiencing heat problems in the current classroom conditions. The survey for teachers also shows that students are very often complaining about the hot classroom temperatures in the summer.

5. Discussion

This study showed that storytelling as an intervention had a significant effect on KS1 pupils' behavioural improvement in response to the hot day at school, and also had some effect on

KS2 pupils, but this effect was limited in comparison to KS1 subjects. Pupils' behaviour and some environmental factors in the classroom (e.g. opening windows, using fans) may have been influenced by the teacher to some extent, but KS1 pupils still demonstrated memory and understanding of the behaviours mentioned in the intervention. The use of the storybook as a thermal comfort education material was also endorsed by the teacher as a very popular way for the engage with pupils, which further suggests that the intervention materials used in this experiment can be effective in changing pupils' behaviours when coping with summer overheating in the classroom. The intervention storybook used in this experiment could be considered for dissemination to students across the UK to enhance students' coping with summer overheating and reduce the health impacts associated with summer heat.

However, this pilot study also demonstrates that both teachers and pupils were dissatisfied with the current classroom environment. Pupils' TSV and TPV showed high levels of thermal dissatisfaction, and teachers noted that classrooms were often overheated during the summer months, with classroom temperatures sometimes reaching over 29 degrees and carbon dioxide levels being high. Several teachers felt that there was a need for a fan or air conditioning in the classroom to improve thermal comfort in the school.

In conclusion, the storybook material used in this experiment is seen to be an effective and liked intervention by KS1 pupils to change pupils' behaviour in response to the high temperatures in school. Therefore, a larger scale experiment will be established next year with more schools involved to further explore the impact of the storytelling intervention method on pupils of different ages and to explore the factors that may influence the effectiveness of the storytelling intervention method.

The scope of this experiment was limited due to the short duration of the July 2023 high temperatures to only one hot day. In future, experiments on thermal comfort interventions with students, will incorporate longer, heatwave periods to obtain more varied data on students' actions to cope with overheating.

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