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Corresponding Author:
caroline.atzl@researchstudio.at
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Kids Love Stories: New Ways of Saving Energy

Caroline Atzl, Bernhard Vockner and Manfred Mittlboeck
RSA iSPACE Salzburg, Austria

Abstract

Saving energy is an important issue in the world of today. The challenge is to raise awareness of energy efficiency and to decrease the overall consumption. In this paper, we present the approach behind the THE4BEES project, which aims to sensitize children and young people regarding the importance of saving our resources. In this context, we designed a new concept that involves pupils from a number of schools in an interactive and interdisciplinary way. They perform various tasks, ranging from the installation and observation of real-time sensors, to performing statistical analysis and the communication and visualization of the results as story maps. Our aim is to find out whether our concept is suitable for persuading children and young people to behave in a more energy-efficient way in their classrooms. In order to do this, we get the pupils to create and tell their own stories on the subject of saving energy. In this paper, we present the theoretical concept and the first results of working with pupils.

Keywords:

storytelling, story maps, energy saving, energy efficiency

1 Introduction

Energy is a valuable resource that enables our actual living standard, but stocks and reserves of oil, gas and coal are running low. The US Energy Information Administration (EIA, 2013) indicates that the world energy consumption will increase by 56% by 2040 and that fossil fuels continue to supply nearly 80% of the world energy use. Thus, it is necessary to save energy at global, local and individual levels. There are various EU Directives, such as the Directive 2012/27/EU, which aim to achieve the 20% energy efficiency goal by 2020. All EU countries are required to use energy in a more efficient way, from its production through to its final consumption (European Commission, 2017). However, energy efficiency is not increasing significantly and major efforts are required to turn the situation around (Renda, 2014). In addition, Renda identified various problems, such as the fact that the Europe 2020 strategy is a set of politically agreed targets and actions that is almost unknown in member states, that the flagship initiatives are too isolated and sometimes in conflict with each other, and that there is a lack of motivation, transparency and sense of ownership of the strategy at the regional and local levels. Although overall energy consumption in the EU has increased over recent decades, it has decreased slightly since 2010 (European Union, 2016). To support this trend, it is important to raise awareness for saving energy at the individual level as well, starting from early childhood.

Heating (17.6%) and hot water (13.8%) are among the top three energy consumers in private households, whereas electric lightning (10.7%) and home electronics (7.6%) are in the midfield (Statistik Austria, 2016). In schools, electric lightning accounts for the largest proportion, approximately 50%, of the overall energy consumption (ENU, n.d.). The change from light bulbs to LEDs can reduce the energy consumption of lighting by up to 80–90% (ibid). More generally, according to Bouslama et al. (2016), the energy wasters in schools are windows that are open for long periods, unnecessarily high heating temperatures, needless lighting, inappropriate cut-off times for water taps, and electrical devices that are left on standby even though nobody is using them (e.g. computers left on overnight). Internal measures regarding energy saving can help to decrease the overall energy consumption in schools by up to 10% (BMLFUW, 2014). Thus, we want to help schools to save energy and to facilitate the implementation of suitable measures, using sensors from the home automation sector, to provide live information on the energy consumption in classrooms.

In this paper, we give some insights from the EU Interreg Alpine Space project THE4BEES (www.alpine-space.eu/projects/thefourbees), which focuses on the behavioural changes of users in public buildings needed to achieve a reduction of energy consumption. The project is currently at an early stage regarding the technical implementations and user evaluations. Our use case study within this project aims to persuade pupils to save energy in schools by using live measurement data gathered from sensors within their classrooms. The research questions are 'How do you involve kids in energy saving and let them tell stories about this in a way that is appealing and easily understandable?' and 'What should a concept that involves kids in the different project phases and workflow stages look like?'.

To get the attention of individuals – adults as well as children – new ways and concepts are necessary to communicate the need for (and the personal benefit of) behaviour changes regarding a specific challenge such as energy saving. Storytelling maps are novel means that help to present different types of information in an exciting and powerful way. Story maps tell the story of an event, place or trend in a geographic context (Harder, 2015). These kinds of maps enable interactive maps (2D and 3D), text, images and other multimedia files to be combined in order to tell stories that are easily understandable and grab the attention of the 'reader' (ESRI, 2016). Since the beginning of time, humans have loved to tell and listen to stories:

> Tens of thousands of years ago, [...] we were telling one another stories. […] We are, as a species, addicted to story. Even when the body goes to sleep, the mind stays up all night, telling itself stories. (Gottschall, 2012, p. xiii)

Our aim is to benefit from the human liking for stories and thus to bring together real-time sensor measurement data, descriptions, images and diagrams to tell people – especially children – stories about how important it is to save energy. We present a new concept for working with school classes, the technical workflow behind our use case, a prototypical storytelling map, and first results from working with pupils in this context.

2 Concept

Our concept is tailored to our use case, where pupils should be motivated to save energy in classrooms and, in the best case, adopt long-term behaviour changes based (among other things) on the illustration of the impacts of saving energy (e.g. amount of money saved per year). There are different approaches for working on behavioural changes and one aim of the project is to find out whether any kind of behavioural change can be achieved using our approach. During the project, we are working with four classes from two partner schools in Salzburg (a technical and a scientific-oriented school) to evaluate or concept. The pupils are between 15 and 17 years old. In addition, we have project partners across Europe working with various schools and institutions on saving energy. At the very end of the project, comparisons are planned.

The detailed concept is shown in Figure 1. The raw workflow is illustrated in the top area. There are different types of sensors that measure specific phenomena (e.g. room temperature, window open/closed) at predefined intervals. The sensor values are stored in a database and are analysed, or the data is filtered to extract specific information (e.g. the correlation between room temperature and how long the window is open for, or the costs per day when the heating is turned up by one degree). The sensor values are also directly integrated into the story maps to be shown in real-time. All the data – raw, analysed or filtered – are published as web services and are integrated into storytelling maps for visualization purposes.

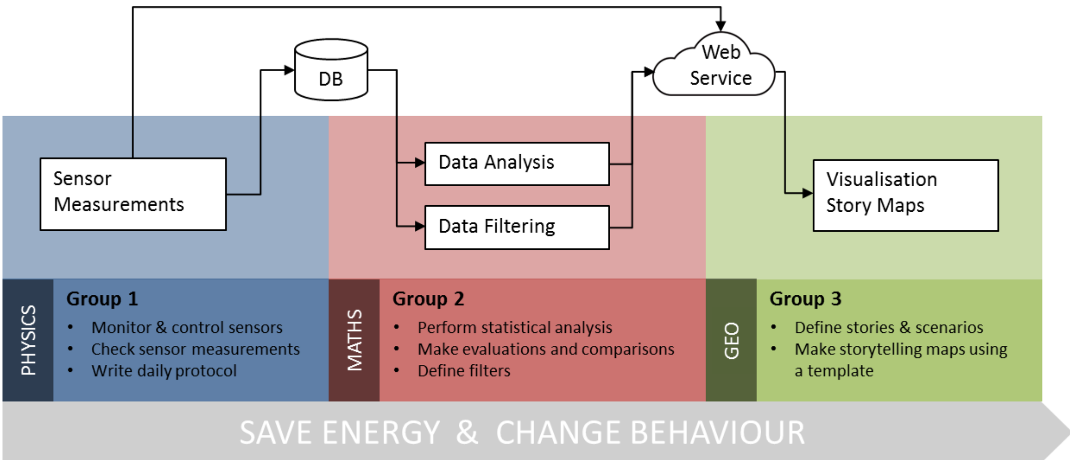

Figure 1: Concept for the workflow and its division between groups of pupils for saving energy in the classroom

The different tasks of the workflow are split between three groups. Each group represents one third of the class and covers one of three subjects (physics, mathematics and geography). The first group is responsible for observing the sensors, the second for performing statistical evaluations, and the last for creating the storytelling maps using a predefined template that can be completed with information. There is a workshop for each of the three tasks and the pupils receive detailed instructions. In addition, the groups are supported by experts for the duration of the project.

The live feedback, the possibility of comparing different time periods from past to present to see the changes in energy consumption, and the opportunity to be responsible for a specific task contributing to energy saving should convince pupils of the need to change their behaviour and to be motivated to save energy, at home as well as at school. How well our concept works and leads to the desired results is evaluated during the project. The overall aim is to compare the data within classes, between classes and across different schools.

Now it is up to the pupils to tell us their stories about saving energy in their classrooms using real-time sensors and story maps.

3 Realization

The first step for realizing the concept was to install the sensor system in our lab and to make a prototypical story map. This map helps to present the idea behind the THE4BEES project to pupils and teachers and to show them how powerful storytelling maps can be. The next step is to equip the classrooms with some specific sensors and to enable the pupils to fulfil their tasks to 'observe' (group 1), 'analyse' (group 2) and 'visualize' (group 3) the sensor data (see Figure 1). The corresponding technical workflow is shown in more detail in Figure 2.

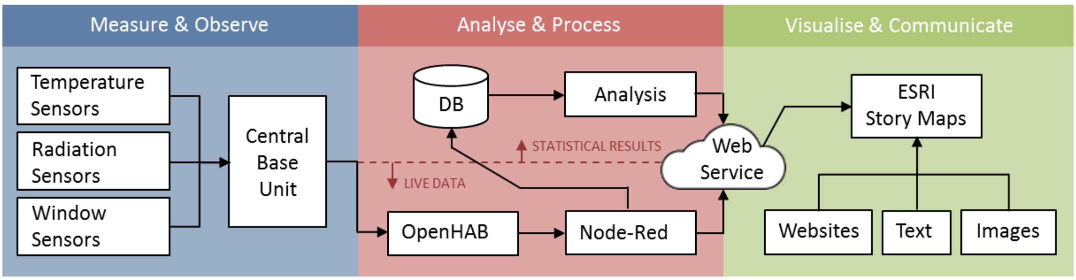

Figure 2: Technical workflow

Task 1: Measure and Observe

The idea is to collect some specific parameters in classrooms that can be used to draw conclusions about saving energy. Therefore, different sensor types are used for collecting real-time data about the environment (see Figure 2):

- **Temperature** (indoor and outdoor): Several sensors measure the current temperature and humidity at various locations within the room. In addition, the temperature and humidity outside are measured to allow correlations between these measurements to be observed.

- **Heating system:** There are sensors mounted directly on the radiators that are used to control and observe adjustable parameters (i.e. desired room temperature, heating times) to increase energy efficiency. The measured outdoor temperature can be used as a reference value for regulating the heating system.
- **Window state** (open or closed): Sensors attached to the windows send information about the current window state (open or closed). This enables conclusions to be drawn about how fast the indoor temperature decreases when the window is open, taking into account the current outside temperature.
- **Base station:** All sensors transmit their measurements to a central base station via radio. This central control unit enables a simple control and configuration of all the sensors via a user interface. The current measurements can be requested from the central base station for processing or storing.

The group that is responsible for this task has to help install the sensor system, monitoring the functionality of the sensors, configuring the user interface of the central base unit, and writing protocols. In addition, the pupils can use a CAT S60 smartphone that includes a thermographic camera to inspect the school building in more detail.

Task 2: Analyse and Process

The sensors send their current measurement values only, i.e. without any additional information (e.g. their location). Thus, the sensor measurements queried from the central base unit have to be structured and enhanced with some kind of metadata for visualizing them in maps (see Figure 2). We use OpenHAB1 – an open source software for home automation – for requesting the sensor data at a predefined interval from the base station, for organizing these data, and for enriching them with metadata (e.g. geographical location, timestamp). For the integration of the real-time sensor data into ESRI Story Map Templates2, the data has to be transformed into the correct format for publishing them as ESRI ArcGIS REST Service. Therefore, we use Node-RED3 – an open source flow editor. The flow created within Node-RED retrieves the data from OpenHAB in XML-format, converts them into JSON-format, parses the specific parts out of the JSON-data, and puts them together in the right form for publishing the data as ESRI ArcGIS REST Service, using the ESRI ArcGIS GeoEvent Processor. This web service can be integrated into any ESRI Story Map. In addition, the sensor data are stored in a database for archiving and analysis purposes.

The group of students at the technical school that is responsible for this task has to create the Node-RED flow for processing and formatting the sensor data using the graphical user interface (GUI) of Node-RED. This requires some small programming elements. The group of the science-oriented school has to perform statistical evaluations. The analysis results can be integrated into the story maps via a web service.

[1] http://www.openhab.org/
[2] https://storymaps.arcgis.com
[3] https://nodered.org/

Task 3: Visualize and Communicate

To bring all parts together – live sensor measurements, analytical results and the overall story regarding energy saving – the ESRI Story Map Templates are used. ESRI provides different layouts that can be easily adapted and filled with text, images and maps that make the story. Story maps are powerful means for communicating topics in an easily understandable and appealing way. Thus, story maps are also suited for children and young people, both as users and as creators.

In the words of Harder (2015), storytelling has 'the potential to affect change, influence opinion, create awareness, raise the alarm, and get out news'. In the case of the THE4BEES project, we want to find out whether the pupils like working with story maps and whether story maps have the potential to change behaviour. We created a first prototypical story map (Figure 3) that we use for presenting the THE4BEES project and making the first evaluations with pupils.

Figure 3: Prototypical story map

The story map consists of several sections, each presenting a part of the overall story. For example, our prototypical story map starts with a short introduction to the THE4BEES project, followed by a section about saving energy, and ending with a 3D map that shows a classroom including the sensor locations and their real-time measurements within pop-up windows (Figure 3). The user navigates through the story map by scrolling down and experiencing the different sections of the story.

The groups that deal with this task ('visualize and communicate') have to define stories about saving energy in their classrooms and to fill in storytelling map templates with content. These story maps can be used for presenting the results of the project to others (e.g. at open days, parent conference days or exhibitions).

4 First Results

The project is currently in its initial phase: we have created concepts and the first prototypes, as well as presented them to encourage schools to participate in the THE4BEES project. The idea is to involve the pupils from the outset in all the different project stages. This includes collecting feedback from the pupils about what they think the biggest energy consumers in their classrooms are, and what sensors they would install to collect relevant information for increasing energy efficiency in schools.

Thus, we held a small informal session (an 'unconference') during the GIS Day in Salzburg (2016-11-16) for pupils from different schools, where we presented the project and a prototypical story map regarding saving energy in classrooms. We collected answers regarding what the biggest energy consumers in classes are, let the pupils take thermal photos using a CAT S60 smartphone, and let them interact with the story map we presented.

Figure 4 shows the results from the question posed at the session concerning the biggest energy consumers in schools. In total, we received 28 brainstorming sheets from four different classes, each completed by a small group of three to four pupils. The three most-mentioned consumers were 'computers & electrical devices' (30%), 'heating' (29%) and 'electric lightning' (17%).

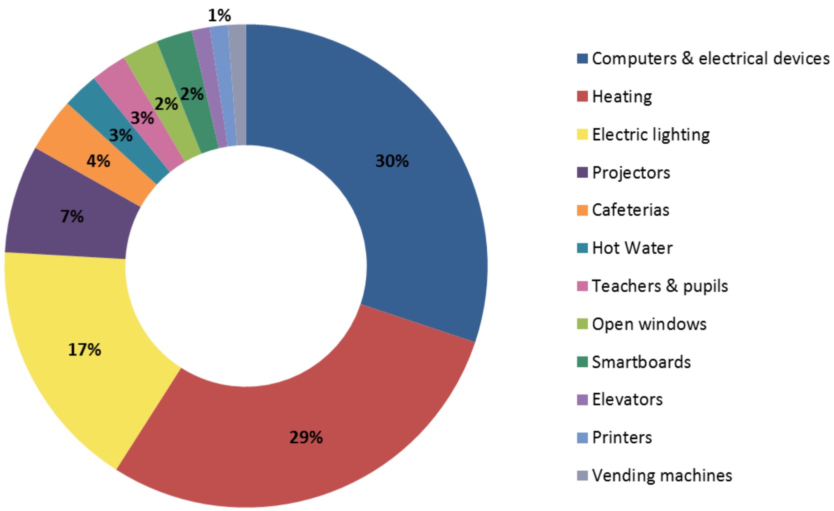

Figure 4: The biggest consumers in schools from a pupil's perspective (number of participants = 28)

The pupils had lots of fun collecting thermal images and they were motivated in contributing to save energy. We also received positive feedback regarding the story map presented. The pupils liked the simple interactive idea behind story maps in general and said that they could imagine using them more often in future.

Additionally, we carried out a short survey with seven participants (four pupils and three project team members) during the installation of the sensors in the classroom at the technical school. All participants mentioned that the current problem in the field of energy efficiency is that there is 'little awareness', and three stated that the 'electricity and heat consumption is too high'. As possible behavioural solutions, 'rush airing4' (seven times), 'turning off lights when not needed' (six times) and 'avoiding overheating of classrooms' (three times) were mentioned. Figure 5 shows what kind of data should be measured from the participants' perspective. 'Temperature' (indoor, outdoor, and that of the radiators), 'electricity consumption' and 'air quality' were most frequently mentioned. The need for sensors that detect whether the 'windows are open or closed', 'humidity' and 'motion' (e.g. for lighting in specific areas) was stated by the participating team members only.

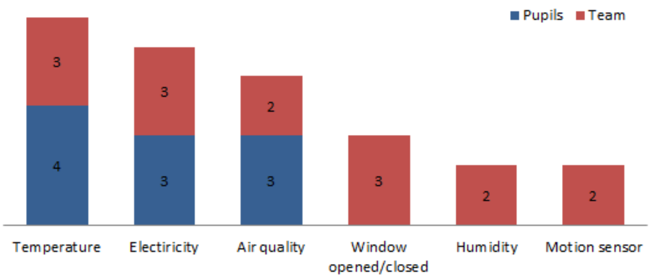

Figure 5: Types of data that should be measured by the sensors in classrooms (number of participants = 7)

All participants were in agreement that the most important feature of a communication tool (such as story maps) is real-time data integration. The 'visualization of analysis results' and 'temperature profiles' were each named twice. In addition, story maps should 'support the national language' rather than provide content in English only.

Our first unconference and small survey show that the pupils are motivated to increase the energy efficiency of their classrooms. They know what the biggest consumers are, and so know how they can change their behaviour to save energy, and which sensors are needed to get the necessary information. They also like the idea of presenting the results in story maps. More comprehensive user tests and further sessions including more pupils from the different schools are planned in the upcoming project phases.

5 Critical discussion and Outlook

The THE4BEES project is at an initial stage only, where the focus has been on the development of the theoretical concept introduced here, rather than on the implementation

[4] Opening a window fully for a short time instead of opening it partially over a longer period.

and evaluation of this concept. The concept is divided into three parts, each including tasks that can be related to a school subject (geography, physics, maths). This enables the pupils to constitute groups and to work in teams depending on the topic they are most interested in. Additionally, we use the power of story maps to excite and motivate pupils and allow them to combine different media (text, images, live data, maps) in developing the story maps' content. The concept is innovative and promising, but has not yet been tested enough to demonstrate conclusive results.

The pupils are involved in all project phases. Thus, they are also involved in brainstorming sessions to collect useful information regarding their views on what the biggest energy consumers in classrooms are, and what sensors are needed to obtain relevant data. Here, we have presented the first results of a small unconference during the GIS Day in Salzburg at the end of 2016 and of a short survey with a few representatives from the technical school that is one partner in the project. The number of participants was small, but these initial results show that our approach is potentially useful.

A comprehensive evaluation of the concept and the prototypes can only be carried out at a later stage of the project. We also plan to find different solutions to communicate the results and to develop instructions to the pupils (e.g. open the window for 5 minutes to get better air quality). Therefore, further data and content are needed. The next step is to hold interactive workshops where the pupils will receive instructions and support for performing their specific tasks (e.g. constructing the footprint of the building for the 3D visualization, installation and registration of sensors, performing some kind of analysis, filling in storytelling templates). The overall aim is to involve the pupils during the whole project and to motivate them to save energy in a new and innovative way.

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