



Inspiring Girls for STEM Careers: Escape Room Game on the Topic of Energy in Buildings for Girls' Day

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Abstract

In 2024, only 16% of employees in the fields of mathematics, computer science, natural sciences and technology (STEM) in Germany were women. [1] The Girls' Day program offers pupils in fifth grade and above (girls in the age of 10 to 17 years) practical insights into career fields in which women are still significantly underrepresented. During the program, they can visit companies and institutions and learn about the relevant career fields. [2] Since 2001, the German Federal Government has also been specifically supporting this initiative, which has so far offered more than 2.38 million places. [3] Aachen University of Applied Sciences is also proud to participate in this program for girls. The students should not only be informed about the possibilities of studying engineering, for example, but should also become active themselves. In order to make complex topics in the field of building technology more tangible and fun to experience, teachers and staff of the Smart Building Engineering program have developed a game similar to an "escape room", in which the students have to solve tasks on the topic of "energy consumption and energy savings in buildings" in small groups at various stations. Each task then leads to the next. Only if all tasks are solved correctly within the allotted time the overall problem can be successfully solved. The participating students had a lot of fun with the format and solved the game well. Their interest in complex issues such as energy consumption, savings opportunities in buildings, and thus climate protection was awakened in a playful way and should be continued in future.

Keywords: *Girls Day, Escape room, STEM education, Smart Building Engineering, Building technology*

1. Introduction

In 2024, only 16% of employees in the fields of mathematics, computer science, natural sciences and technology (STEM) in Germany were women. [1] Although girls have been more likely than boys to obtain their Abitur in Germany since the 1980s, and even though more girls are starting university studies in Germany (52%), they are in the minority in STEM subjects at universities. [4] The proportion of women among first-year students in the STEM field was just under 35% in 2022, but varies greatly from subject to subject: According to the Federal Statistical Office, the proportion of women in STEM courses ranged from 87% in interior design to 8% in automotive engineering. [5] There is already a shortage of skilled workers in STEM professions, with more than 150,000 employees missing in this important field. Due to demographic change, demand will continue to grow in the future. [6] Against this background, numerous initiatives are trying to inspire girls to pursue technical careers, regardless of gender stereotypes. The Girls' Day program offers pupils in fifth grade and above (girls in the age of 10 to 17 years) practical insights into career fields in which women are still significantly underrepresented. During the program, they can visit companies and institutions and learn about the relevant career fields. [2] Since 2001, the German Federal Government has also been specifically supporting this initiative, which has so far offered more than 2.38 million places. [3] Aachen University of Applied Sciences is also proud to participate in this program for girls.

2. Aims and Requirements for the Girl's Day Program

The promotion of young women in the STEM field is particularly important to FH Aachen University of Applied Sciences. For this reason, numerous departments and study programs at FH Aachen participate in the annual Girl's Day with interesting offers for girls. [7] The pupils should not only be informed about the possibilities of studying engineering, for example, but should also be actively



involved. They should not just have a look at technical professions, but experience and try them out for themselves. The teachers and staff in the Smart Building Engineering department were also keen to show the girls their field and give them a better understanding of it. The aim was to introduce the girls to typical questions in this field in a playful way and to have fun finding a solution to a technically complex problem. Small experiments should both encourage reflection on the problem and provide space for experimentation and exploration. In order to make complex topics in the field of building technology more tangible and fun to experience for the girls, the team of the Smart Building Engineering program have developed a game similar to an "escape room", in which the students have to solve tasks on the topic of "energy consumption and energy savings in buildings" in small groups at various stations.

3. Design of the Game

For Girl's Day, a game on the topic of "Energy and Saving Opportunities in Buildings" was created. The game's concept is similar to an "escape room" game. The students work in small teams to decipher clues and solve small tasks and riddles. The solution or selected answer leads to the next task. Only when all tasks have been correctly solved in the correct order and within the given time the entire riddle can be solved. The students began with a brief introduction to the topic and a few practical tips on handling, for example, one of the measuring devices used, to ensure the smooth running of the game. The following initial scenario was assumed for the game: Energy crisis! A smart building equipped with sustainable technology has been crippled by a hacker attack. The energy systems have failed, and electricity consumption is rising rapidly. The students have 30 minutes to get the technology up and running again and save the building!

The participating girls started in three groups, each staggered by five minutes, so that each group could progress smoothly through the game without long waiting times. All stations were set up in a large room, so the girls could always go to the appropriate station without disturbing each other or hearing the results and thoughts of the other groups. A timer was started for each group at the beginning, so that the time counted down for each group, and afterwards it could be determined which group completed the game fastest. This created both a certain amount of time pressure and a slight competition between the groups.

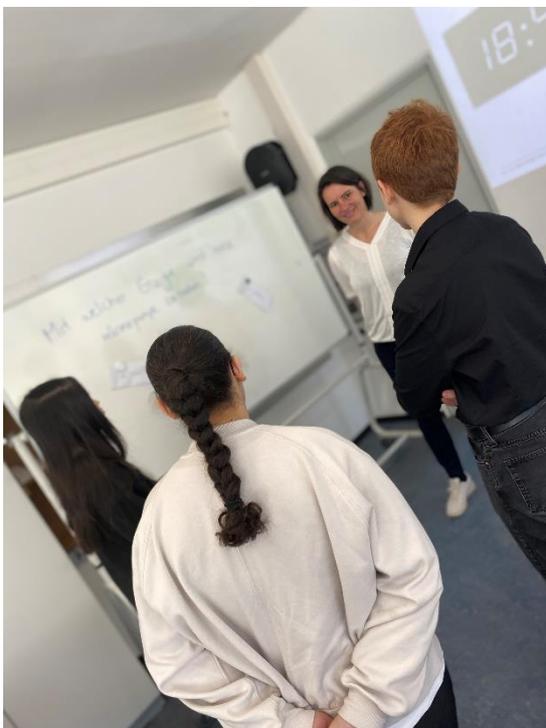


Fig. 1. One group of three girls solving the first of the game's riddles (left) and opening the locked black plastic box with the correct numeric code after solving one of the game's riddles (right), © FH Aachen, Birgit Greeb



The first station in the game began with a question about the energy source used to power heat pumps. One of three answers had to be chosen. In the corresponding envelope was a key, which the girls then had to use to find and open a locked plastic box in the room to unlock the next riddle. The next box dealt with electricity consumption. The box contained a measuring device and several electrical devices. The girls were asked to measure and calculate the electricity consumption, specifying different usage times for each device. The devices were then to be sorted according to their electricity consumption. All devices had a number labeled on them; the numbers of the three devices (hairdryer, cell phone charger, screen) formed a code, which then opened the combination lock on the next plastic box. Once the next box was found and opened with the correct code, the girls found a thermal imaging camera inside, which they had to use to measure the surface temperatures of three metal bottles filled with different amounts of water. These bottles also had numbers on them, which, when placed in the correct order (from cold to warm), formed the code for the combination lock of the next plastic crate. Hidden inside this crate were questions about energy saving in buildings, and the girls had to consider which system could most efficiently detect whether a room in a building was currently in use or not. The following answers were available:

- A fixed timer that turns the heating and lighting on and off at specific times.
- A motion sensor that detects whether people are in the room and controls the lighting accordingly.
- A combination of occupancy, temperature, and CO₂ sensors that automatically adjust the heating, ventilation, and lighting.

The correct answer again led to a new box containing the message that the hacked building's power system had been successfully reactivated. This box also contained a few small sweets to "save" the girls' own "power system." This marked the end of the actual game.

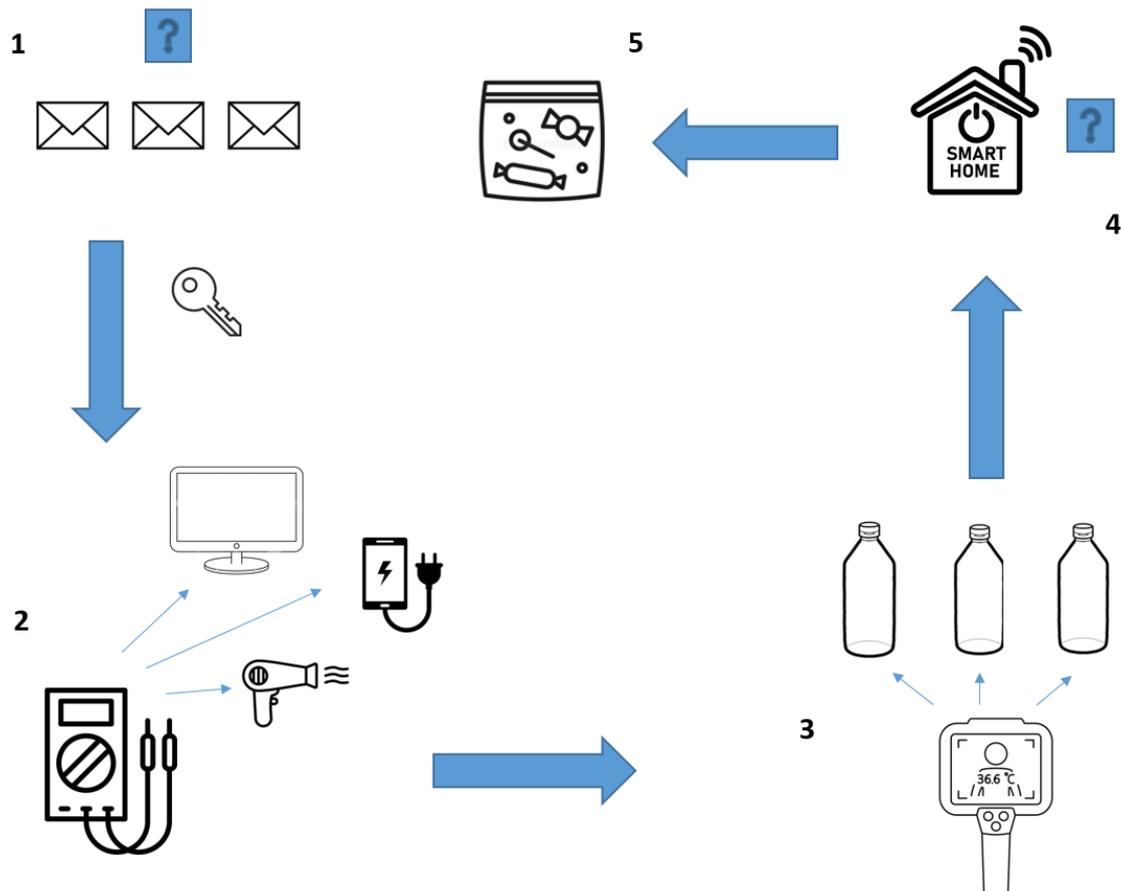


Fig. 2. Flowchart of the game showing all stations in the correct order: Question about heat pumps which leads to the key for next box (1), energy consumption measurements and calculations (2), thermography measurements (3), question about building automation (4) and last box of the game with some sweets inside (5). © FH Aachen, Lina Schulze-Buxloh



Once all groups had successfully completed the game, a short reflection period was held to summarize the aspects of "energy consumption and energy savings in buildings" the girls had learned through the game. From their own measurements of energy consumption at a gaming station and their calculation of energy consumption based on the length of use of a device, they saw that the length of use is a crucial factor in energy consumption. The girls also noticed that manufacturer specifications do not always match the actual measured values, and that it is better to rely on a measurement rather than on a device's label.

At the thermal imaging station, the girls could see and feel for themselves how good thermal insulation reduces heat losses to the environment. The same applies to the building envelope, demonstrating why good thermal insulation translates into lower energy consumption.

The last question, about the most intelligent and efficient control of a building, showed the girls that unnecessary energy consumption can be minimized through demand-based control and appropriate sensors.

All of these aspects are part of the interdisciplinary Smart Building Engineering program at Aachen University of Applied Sciences, which combines elements of civil engineering, architecture, communications and electrical engineering with modern planning methods such as Building Information Modeling (BIM). Graduates are able to translate the diverse requirements of modern buildings (i.e. design, construction, technical equipment and system integration) into technically, aesthetically and economically optimized building technology solutions and thus also make a contribution to climate and environmental protection. Hopefully more girls will dare to study this course in the future and work in this important field.



Fig. 3. One group of four girls solving one of the game's riddles after opening the black plastic box (seen at the bottom left of the image) with the correct numeric code. © FH Aachen, Carolin Mahr [7]

4. Outlook

The game was very well received by the participating girls, who clearly enjoyed solving the puzzles on the topic of energy in buildings. They also seemed to enjoy being able to actively try things out and experiment, rather than just watching or listening to a lecture. Solving the tasks independently also motivated the students to engage with the complex topic. This playful introduction to an area of the engineering profession could certainly contribute to more girls choosing to study engineering in the future. Aachen University of Applied Sciences will certainly participate again next year, giving girls the opportunity to learn about technical careers.

The "escape room" concept was so well received by the teachers and staff that they are considering how a similar concept could perhaps be implemented in teaching, for example, in the first semesters



of the program. Even though setting up such a game involves a certain amount of effort, it will certainly be used more often in the future.

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