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Experiences on using a geothermal-themed escape game to awaken STEM interest in adolescents

Medgyesi, N.,[1,2]*, Sidorova, A.[1,2],Richels, N.[1,3]
Technical University of Munich[1], Geothermal Alliance Bavaria[2], Ludwig-Maximilians-University, Munich[3]

INTRODUCTION

- The Bavarian Molasse Basin in southern Germany is with 26 operating heating and CHP plants one of the most extensively used hydrothermal regions in Europe
- Only 40 % of the German population are aware of the geothermal potential to heat and power houses and industry[1]
- A shortage of skilled workers is one of Germany's most significant obstacles to future geothermal expansion
- The concept of geothermal energy is not part of the school curriculum
- Geothermal energy is a complex subject, which requires interdisciplinary understanding
- Women are underrepresented in technical vocations, including geothermal energy
- A geothermal project day for adolescents was created within the "TUM Entdeckerinnen" Project at the Technical University of Munich's study orientation program
- The primary project aims to awaken girls' interest for STEM subjects shortly before they decide to pursue vocational training
- Geothermal is one of 11 courses offered by the program to rural schools

METHODS

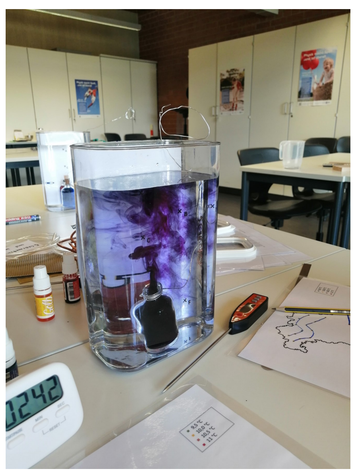
- The project is in a traveling classroom style
- Participating girls should work independently on a series of hands-on experiments
- Participating girls should feel a sense of achievement at the end, however learning through mistakes along the way is encouraged
- All materials (except for rock samples) are available in hardware or kitchenware stores
- We start with an introductory session: a quiz around the energy system with the role of utility companies and a short presentation around the concept of geothermal energy
- The escape game has ten challenges through which the girls should identify the local geothermal resource for their town
- Each challenge is addressing one key feature of the geothermal system, such as comparing porosity and permeability of different rocks, predicting local depth of the reservoir and drilling through a sedimentary sequence
- Each challenge contains the necessary materials and concludes with a single-choice question to prove their understanding. If answered correctly, it unlocks the next challenge

SNAPSHOTS FROM THE ESCAPE GAME

Challenge Geology:
Which explanation to the rocks in the box remains unpaired ?
This rock is not present in Bavaria.



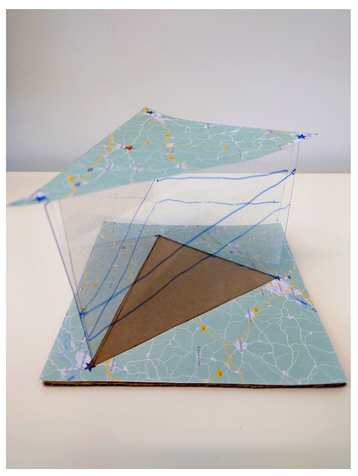
Challenge Heat transport:
Which form of heat transfer is more desirable in the reservoir: convection or conduction?



Challenge Hydrogeology:
Which material has higher porosity and which higher permeability, sand or gravel?



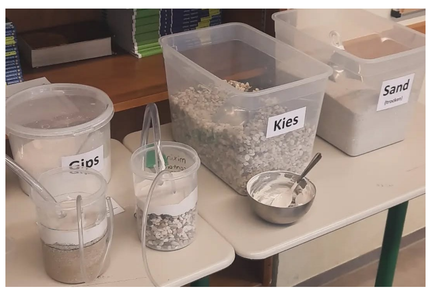
Challenge Reservoir Depth:
Interpolate the local depth of the reservoir with help from the data from the neighbouring plants



Challenge Drilling:
Drill through a sedimentary sequence with augers and casing (steel bubble tea straws)



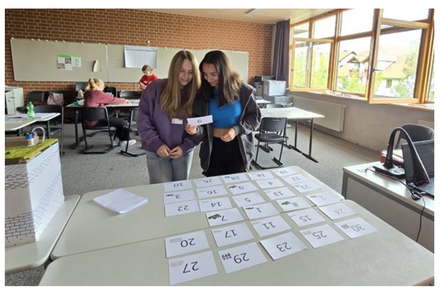
Material Station:
Sand, gravel, gypsum with a scale, measuring cups, water and a kettle are needed throughout the challenges



Material Station:
Challenges waiting to be solved. Each envelope contains the single-choice question and instructions, if necessary



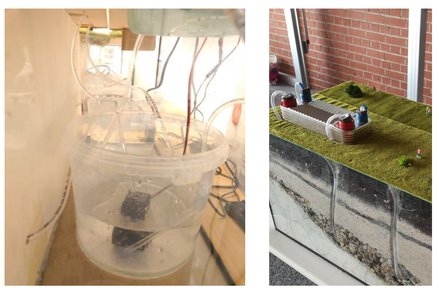
Solutions Table:
The right number unlocks the next challenge. If a wrong answer is given, a hint helps to guide to the right one.



Wrap-Up Session:
Geothermal heating plant model. Measurable temperature rise in the pool. Connects the challenges to the components of a geothermal heating system.



Wrap-Up Session:
Behind the scenes: Hot (reservoir) & cold (heating grid) tanks with aquarium pumps are connected with a heat exchanger.



RESULTS & DISCUSSION

- **Before the project day, most girls believed that a sustainable future depends more on individual lifestyle choices than on career paths**
- Adolescents are unaware of the magnitude of energy needs for heating vs. electricity
- While wind and solar are known renewable power sources, renewable alternatives for heating are widely unknown
- Despite living in one of Europe's most active hydrothermal regions, and sometimes even having an active drilling rig within 10 km to the school, only a few participants had ever heard of geothermal energy before
- Most participants are scared of maths and geometry
- Breaking down geothermal energy systems into ten smaller challenges can help to reduce fear of complexity in STEM subjects
- Girls realize the importance of utility companies and local sourcing of renewable energy
- They are thankful for the opportunity to meet young role models who teach them practical topics in an interactive way instead of teaching theory in a traditional manner
- **After the project day, participants realize that a sustainable future depends also on career paths, and strengthen their belief in collective impact and group efforts**

CONCLUSIONS & LESSONS LEARNED

- Around 100 girls participated in the project until now
- Although most participants were sceptical at first, they showed strong enthusiasm during the workshop
- We hope our project can help bridge the knowledge gap and challenge misconceptions and stereotypes around (sustainable) energies
- We're grateful for the opportunity to learn from these experiences and are encouraged by the positive feedback received from both the girls and their schools
  - "the experiment with the colourful water for heat transfer looked cool and pretty"
  - "geology is more interesting, than I previously thought"
  - "we felt, the enthusiasm of the supervisors for the topic during the day"
  - "I still think this won't be my career choice, but the course content helps me understand the public discussion around energy a lot more"
- **We hope this project shows the value and fun of geosciences to pupils and highlights the need for talented and motivated young minds within utility companies to meet our basic energy demands sustainably**

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CONTACT
nora.medgyesi@tum.de