



Project Report **MUCtrail**

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Preface by the Tutor

Maximilian Bauer

In the first months of 2020, the call for scientific expertise became loud among policymakers and society at large in response to the COVID-19 pandemic. Nevertheless, experience in many areas shows that the actions of individuals and society are not always guided by scientific evidence. Such science denial, for instance, can result in fewer children being vaccinated.

When the team formed in late 2018, the five students set themselves the goal of reducing that gap between science and society as team scienciety. This venture resulted in MUCtrail, an interactive adventure trail that introduces the scientific method to children (and the generations of their parents and grandparents) in a playful way. By exploring various stations, centered around the topic of urban climate and built upon a mobile web application, visitors to the Olympic Park can learn the basics of scientific work: observing, generating hypotheses, testing in experiments, and drawing conclusions from data.

The underlying idea behind this approach is the observation that knowledge of the scientific method is limited in large parts of the population. Around this main observation, the realization of the project was remarkable in several aspects:

When I joined to support the team, I had some concerns regarding the vague objectives behind the original scienciety concept. However, by dovetailing (on the team's initiative) the concept of design thinking with the framework the TUM: Junge Akademie sets, the team managed to diverge and converge their ideas in an organized fashion. Thus, the students found a way to tame the chaos that can always occur when different backgrounds collide in interdis-

ciplinary projects. The team's committed, cooperative, and goal-oriented way of working was exemplary.

Also remarkable is the product the team has created. MUCtrail does not only impress with its attractive appearance and professional technical implementation. The cooperation with the Department of Environment and Health of the City of Munich ensures that MUCtrail is available to the general public and will continue to exist in the long term. This sustainability sets the project apart from many student initiatives that do not get beyond the pilot stage.

Ambitious, moreover, was the accompanying scientific study the team had planned. With an established tool from the field of education sciences, the students planned to assess MUCtrail in an interventional study with school classes from public schools in Munich. However, this plan was eventually thwarted by the ban on school trips and administrative delays during the COVID-19 pandemic.

Even though the project is incapable of answering the question of whether an approach such as MUCtrail will ultimately lead to scientific evidence being heard more in society, MUCtrail is in any case a welcome initiative. Not only has the project been a gain in experience and skills for the students, but also it created an offering from which both science and society can only benefit!

Journalistic part MUCtrail

Have you heard your parents or grandparents talk about how green and calm the city was a few years ago? All the time right!? This is the direct impact of climate change. Climate change is affecting millions worldwide. The rising sea levels, melting of global ice caps, increased variation in temperature across seasons are only some of the numerous other factors negatively impacting the environment.

In this respect, the city of Munich has not been untouched, and its effects are real. The city has expanded with more high-rise buildings than ever before, with technological interventions becoming the norm. Sustainable living practices with a focus on future generations is indeed improving the quality of life. Movements like Fridays for Future started by Greta Thunberg, a Swedish environmental activist, have garnered worldwide support. The youth and children are rallying to take action towards slowing down the detrimental impacts of global warming, dying rivers, and disappearing forests on nature. Inspired by Greta, children in Munich are protesting – by skipping school on Fridays – against inaction and disregard for the harmful impacts of climate change.

Now that we have your attention, we would like to focus on Mia, a young girl curious about science. She is taking a walk around the majestic Olympiapark in the heart of Munich, breathing the fresh air and enjoying the scenic beauty.

She is tired of listening to boring lectures and doing endless assignments on environmental science. She wants to learn about the intrinsic process of science albeit in a playful way.

Forscher Fritz is a climate change researcher. He knows about the scientific method and wants to share his knowledge with the world. He feels that children lack adequate knowledge of the scientific method. Further, he knows that not many children have the privilege and access to learn about research and the process of doing science.

We aim to bring Forscher Fritz and Mia closer together. We want to improve people's attitudes by educating them about the scientific method in the context of climate change. We present to you Munich Urban Climate Trail (MUCtrail), "a playful way to evoke scientific curiosity about climate change."

We developed an online adventure trail with seven stations. Each station depicts a step in the scientific method. We allow Mia to explore the different stations and learn more about the scientific method with quizzes and infoboxes. We conclude with a conversation between Mia and Forscher Fritz. The researcher asks insightful questions about the process of doing science, and Mia answers by applying the knowledge she gained about the scientific method.

And so, the adventure begins! Mia first arrives at the Olympiapark hill and witnesses the tall buildings surrounding the locality. Here she exclaims how hot it is just before the winter. When her mother tells her things were not like this a few years ago, she learns about the concept of urban heat islands. She learns that this phenomenon has an adverse impact on not only the humans but also the animal species dwelling in the region.

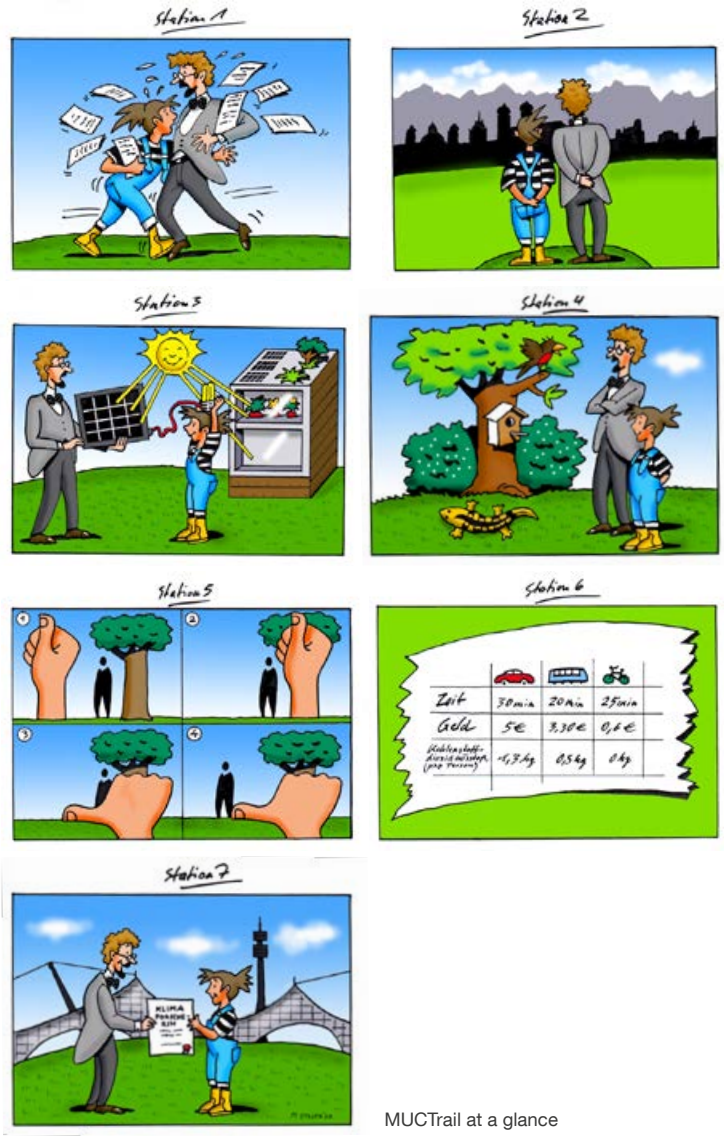
Next, she moves on to learn about green architecture taking into account construction in urban areas. This allows her to observe the environment closely. In the next station, she learns how to formulate scientific assumptions. She does this by learning how she can improve the coexistence of humans and animals in the city. In the Urban Vegetation station, she experiments with determining the tree height. Finally, she learns that it is important to collect data for the experiments to validate her assumptions. She does this in analyzing which transport method is the most eco-friendly in an urban setting like Munich.

In the last station, Mia meets Forscher Fritz to test her learning. Here is an excerpt from the engaging conversation between Mia and Forscher Fritz.

Mia: I think I know much more about the climate in Munich now than I did before! Thank you, Researcher Fritz!
Forscher Fritz: Stop, stop, not so fast! What did you learn about the scientific method?
Mia: Quite a lot. I have to measure and speculate and...
Forscher Fritz: But that's all mixed up! Let's go over it through a quiz.

Researcher Fritz: If I notice, for example, that in summer it is warmer between the houses than here in the park, what do you call that?
Mia: It is called Urban Heat Island. Observation is the first step in the scientific method.
Researcher Fritz: Very good, Mia! For which step of the scientific method is the sentence "I think that the sand lizard seeks stones in the sun to warm itself" an example?
Mia: Ooh, that's a great question. I presume that animals, like humans, experience heat and cold during different seasons. That's probably why the lizard came outside its natural habitat.
Forscher Fritz: Yes, indeed you are absolutely thinking in the right direction. After observation, comes the presumption or hypothesis. Now, do you want to find the height of a tree without using any additional tools?
Mia: I love experimenting. The tree is so much taller than me and has grown bigger than the previous time I was here!
Forscher Fritz: You are so smart, Mia! The next step after observation and hypothesis is setting up experiments. By experimenting, you can collect data for verifying your assumptions.
You are almost there. Last question. You know that there are different modes of transportation in the city. How do we know which is the most climate-friendly option?
Mia: Yes, I do. I compare the carbon-dioxide emissions from cars, buses, trains, and bikes. I always use public transport and ride my bike in the park.
Forscher Fritz: You did it! The evaluation of measured values is the last step of the scientific method by which new knowledge can be gained.
See, it was not so complicated after all!
Mia: Yes, researcher Fritz. Now I know everything about the scientific method and cannot wait to share it with my friends!

Want to be like Mia?
So, what are you waiting for? Grab your phone and head to Olympiapark with an open mind for a journey through MUCtrail – your favorite Munich adventure trail. Experience learning about the scientific method, experience real-world scenarios of climate change in Munich, tickle your brain with interesting puzzles, infoboxes, and much more. Log on to www.muctrail.de and begin an adventure you will never forget!



MUCTrail at a glance

MUCtrail

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Abstract

There is a need to understand and improve the relationship between science and society. Literature shows that people's knowledge about science, especially that of children, is limited. We hypothesize that this may be due to lack of understanding of the scientific method, leading to a negative attitude towards science. To verify the hypothesis we developed an online adventure trail to educate people about the scientific method in the context of climate change. Our project, Munich Urban Climate Trail (MUCtrail) aims to evoke scientific curiosity in a playful way. We use the design thinking approach to understand the problem, define the target audience, develop our idea, prototype, implement and test it. We develop an online adventure trail in collaboration with the City of Munich's *Referat für Umwelt und Gesundheit* with Olympiapark as the backdrop. Each station in the trail educates and informs the user about different aspects of climate change in urban areas while walking through the different steps of the scientific method. The effectiveness of the online tool is assessed by a questionnaire regarding the scientific method supplied to the participants. We observed that participants showed improved knowledge of the scientific method and climate change in an urban environment like Munich. We therefore conclude that a positive attitude towards science should be fostered to enable a greater scientific knowledge.

Background

According to Tubefilter, 2019, more than 500 hours of video content is uploaded to YouTube every minute worldwide. This translates to 30,000 hours of content per hour and 720,000 hours worth content every day. It would take an individual 82 years i.e. an entire lifetime to watch video content on YouTube uploaded only in one hour. It is therefore evident that the internet has contributed to increased accessibility and affordability of information worldwide.

At the same time, misinformation, fake news and selective consumption of information has clouded people's judgment. Objective information analysis and scientific thinking is key to making informed choices. Literature (Im Dialog, W., & Emnid, K. (2018)) shows that several people feel that they do not understand many things about science and research and that 40% consider they weren't taught well in school how science works.

What is the scientific method?
According to Britannica Encyclopedia 2012, the scientific method is the process of observation, questioning, making predictions, setting up experiments, collecting data and validating the hypothesis. The hypothesis is not fixed but is redefined based on the results of these experiments. This iterative process is continued until consistency between hypothesis, observations and experimental tests is reached. Data collection and analysis is the final part of the scientific method leading to scientific discoveries and scientific insights.

Challenges in science communication
Communication of scientific facts to society is challenging. Low levels of vaccination (Robert Koch-Institut (2018)) and low rate of acceptance of genetically modified food are some of the examples of this challenge. Surveys show that scientific education at school is inefficient in imparting knowledge related to the scientific method and scientific process (Im Dialog, W., & Emnid, K. (2018)). Children from disadvantaged sections and lower socio-economic backgrounds bear a heavier brunt due to ineffective didactic techniques (Pupeter, M. and Wolfert, S. (2018)).

Apart from socio-economic background, several factors influence student's success and performance in science classes. One among them is attitude towards science which comprises motivation towards science, perceived difficulty of science, nature of classroom environment etc. (Osborne, J., Simon, S., & Collins, S. (2003)). Though many pupils inherently like science and are interested in it, there is a negative attitude towards school science. According to a study (Ebenezer, J. V., & Zoller, U. (1993)), 73% of pupils believed that science is important at school, around 40% participants found science classes boring. This shows a 'love-hate' relationship between students and science.

Cognitive load is the quantity of working memory resources, which are put into use. Cognitive load is of three types - intrinsic, extraneous, and germane. Intrinsic cognitive load is the effort related to a particular topic, extraneous cognitive load is the manner of presentation to the learner and germane cognitive load is the work geared towards creating a permanent knowledge trove or a schema. Studies (Sweller, J. (1988)) show that domain specific knowledge in the form of schemas determine problem-solving ability and help distinguish novices from experts. Grasping principles of the scientific method requires high cognitive load. There is therefore a need for intervention to reduce the cognitive load on children.

Hypothesis
Attitude towards science has an impact on success in science classes (Osborne, J., Simon, S., & Collins, S. (2003)). We would like to improve the attitude towards science to contribute positively to the professional life of students. Therefore, we hypothesize:

A lack of understanding of the scientific method leads to a negative attitude towards science.

To test our hypothesis, we believe that educating people, especially children and youth about the scientific method is crucial to improving the attitude towards science. Studies show that imparting scientific knowledge through gamification techniques have proved to improve children's attitude and approach towards science (Dicheva, D., Dichev, C., Agre, G., & Angelova, G. (2015)). We utilize this approach to improve scientific understanding among pupils in an interactive and visual way.

Goals and Methods

Our vision is to bring science and society closer together. As science encompasses a variety of fields, we scoped our project to a specific area. We chose climate change as it discussed worldwide and is one of the ongoing challenges of mankind. We aim to reshape the thinking about the environmental impacts of climate change and at the same time educate people about the scientific method, which plays a major role in researching climate change.

To achieve these goals, we designed a new adventure trail with the City of Munich's *Referat für Umwelt und Gesundheit*. The adventure trail is modelled on the topic of climate change in urban areas at the Olympiapark in Munich. Our adventure trail can be accessed here https://MUCtrail.de/.

We reached the idea of developing an adventure trail based on the Design Thinking approach (Brown, T. (2008)). The Design Thinking approach has five stages – Empathize, Define, Ideate, Prototype,

Test – and we will walk you through the entire process pertaining to our project in this section.

Empathizing with audience

Figure 1: Challenges faced by society with respect to science

The empathize phase involves putting ourselves in the shoes of the target audience. In this case, society is our target audience. As a team, we discuss the challenges society faces with regard to science as shown in Figure 1. We took inspiration from relevant literature in the fields of medicine, psychology, strategy, marketing etc. to understand the gaps in science communication to society. We also interviewed more than 10 people from diverse age groups, backgrounds and education levels. We created a questionnaire about perceived challenges between science and society. There were multiple-choice questions as well as the possibility to express opinions in participant's own words. The interviewees expressed that they had not yet been involved in scientific research but were willing to participate in more if provided with the possibility to do so. Some also showed dissatisfaction about the lack of practical teaching while communicating science in school and expressed a need for making the presentation of scientific facts more entertaining and interesting.

Based on our analysis of the literature and interviews, we categorized the main challenges with science communication into three broad areas – education, involvement and communication channel. We developed research questions for each of these three areas. In the area of education, the motivation was to improve understanding of the scientific method in schoolchildren. The second area of involvement was to integrate science better with society. The third aspect was to improve the manner in which science is communicated to society to make it more understandable. The onus was on us to decide our area of interest and how we could maximize the impact of our project.

Project definition

The next step in the Design Thinking process after "Empathize" is "Define". Here we narrow down the scope of our project. The target audience is chosen and the exact problem to be tackled is mentioned here. For our project, we had to choose from the areas of education, involvement and communication channel. After deliberations and discussions, we decided to move forward with the area of education.

We personally had experienced challenges during our formative years of schooling with regard to science communication. We intend to research a better method to facilitate the transmission of knowledge. We decided children between nine to twelve years of age as our target group. As our project evolved, we realized that our adventure trail caters not only to primary school children transitioning to secondary school but also to all school-going children. Our idea is to therefore provide an interactive way to improve the understanding of the scientific method to children using our adventure trail and educate them about climate change.

Project ideation

In Design Thinking, the next step after empathizing with the target group and defining the core problem is to "Ideate". The ideate phase involves creating multiple solutions to the problem at hand and analyzing the solution from different perspectives. After defining the core problem and the target group, we identified competing solutions, which aim to address our problem. As a group, we came up with thirteen ideas to make science more fun and educational at the same time. We voted the five ideas, which best suited our requirements and were in our scope. We deep dived into each of these and analyzed the proposed solutions from multiple angles. Our analysis was based on aspects such as desirability, viability, feasibility, understandability, originality, creativity, measurability and societal impact. The analysis is presented in Table 1.

We finally selected the idea of a science game. It received the highest score among all other ideas. Apart from the numerical value attached to the decision, we received positive affirmation from our tutors for the idea. Further, we attached great personal value to the

Sl. No.	Idea	Desir-ability	Viabil-ity	Feasi-bility	Understand-ability	Original-ity	So-cietal impact	Cre-ativity	Measur-ability	Final Score
1	Science Candy	5	3	4	5	5	3	3	2	30
2	Science Game	5	5	4	4	3	4	3	3	31
3	Kasperl-theater	2	3	4	4	3	3	3	2	23
4	1$-box	4	3	3	4	2	3	2	3	24
5	Science Hack	3	2	2	3	1	2	1	4	18

Table 1: Idea assessment

idea and were able to visualize ourselves working towards making the science game a reality. We refined our research question further and shifted the focus on analyzing the impact of a science game, played in venues outside school in improving the children's understanding of the scientific thinking process concerning climate change.

Initial prototype

The stage was now set for building a "Prototype" of the science game. The prototype phase involved tinkering with possible product ideas after finalizing the idea. With inputs from all team members, we finalized the elements of our prototype. As shown in Figure 2, the adventure trail would include playful elements and interaction with nature. This would contribute to enhancing the learning experience for children. Experiment-based learning would allow hands-on training and enhance the learning of the scientific method with respect to climate change.

After developing the prototype, we searched for internal and external partners willing to support us. We required expertise on implementing the adventure trail and ideas to make our project sustainable in the long run. We pitched our idea to a forest discovery planner, a museum planner, the manager of *Würm-Erlebnispfad* (City of Munich), the manager of *Walderlebnispfad Freising* among others. The initial idea was to turn a small hut in Freising into an adventure trail. The idea was to revamp the interiors, create small stations to educate visitors about aspects of climate change and make it attractive especially to children. However, creating physical stations at Freising required our presence on-site. This was a deal breaker as we had to dedicate time during the lecture period to university. Working on weekends was not an option due to unavailability of a workforce to build the physical stations. Though the idea was attractive, we let it go and continued exploring other feasible and sustainable options.

As discussed earlier, we wanted to create an adventure trail which would be easily accessible to children, easy to use and sustain in the long term. We therefore finally decided to develop a new online interactive adventure trail for the existing online platform for the City of Munich's *Referat für Umwelt und Gesundheit*.

Figure 2: Elements in adventure trail prototype

Outcome and Discussion

Run up to station design

As a location the Olympiapark seemed to be the ideal choice, as it is situated close to the city center, well reachable by public transport and often visited by tourists as well as citizens. Furthermore, one has a good view over the city from it's hills and even though this gives it an urban flair you are still in a natural environment, which we deemed important to transport our messages. The duration for completing the trail we set to 30-45 minutes, so the activity would fit well into a family walk and not be considered as too time consuming by many. As our trail features the different stages of the scientific method we wanted 4-6 stations, each focusing on one single aspect of this method as well as a station for introduction and conclusion. Together with our collaborators at the *Referat für Umwelt und Gesundheit*, who wanted the trail not to have a mandatory order, we finally decided on six stations. As each station requires a certain level of interaction with one's environment they are settled in six distinct locations, connected by an interesting walk offering varied views of the park.

Figure 3: Online MUCtrail in Olympiapark Source: https://MUCtrail.de/

Station Design

To present our content more appealing to children between the age of nine and twelve years, we decided to embed our contents into a story. The protagonists are *Mia* - a girl of about 10 years – and *Forscher Fritz* – a climate researcher. By accident these two meet at Olympiapark and *Forscher Fritz* offers to tell *Mia* more about the climate (change) in Munich and how a scientist conducts his research. Therefore each station is about one specific aspect of urban climate (or another related subject) and one step of the scientific method (s.o.) (Bertemes, J.-P. (2013)). In the following the individual stations are presented.

Urban Heat Islands

The station **"Urban Heat Islands"** is located on the main hill of the Olympiapark, which offers a great view over the city. From here, the participants can observe that the buildings are usually situated quite close to each other. They learn that this influences the urban climate and that a 10°C difference in temperature exists between the city and its surroundings. (Lang, W., Pauleit, S., Brasche, J., Hausladen, G., Maderspacher, J., Schelle, R., & Zölch, T. (2018)). As for the scientific method the station focuses on "literature search" as part of the step "observation".

Green Architecture

The next station **"Green Architecture"** focuses on the different possibilities to render living in the city more friendly to our environment. The participants learn that the use of some isolation materials should be preferred over others (Baunetz_Wissen. Retrieved from https://www.baunetzwissen.de/nachhaltig-bauen/fachwissen/baustoffe--teile/waermedaemmstoffe-682729), and that it is possible to minimize the energy needed for heating by using sustainable sources like the sun (Passivhaus Institut (2015)) Furthermore, this station is about "observation" of one's surroundings as a starting point for further scientific considerations.

Animal-Aided Design

The station **"Animal-Aided Design"** is about the importance of taking the welfare of animals into consideration when designing a city. It portrays the sand lizard and the house sparrow as two examples for animals whose habitat is endangered in human settlements (Hauck, T. E., & Weisser, W. W. (2015)). The participants are being motivated to formulate hypotheses how their survival in urban areas can be facilitated. On the "hypothesis" lies a special focus, as it is one of the steps of the scientific method.

Urban Vegetation

At the station **"Urban Vegetation"** the participants learn that trees worldwide grow faster due to climate change (Pretzsch, H.,

Biber, P., Schütze, G., Uhl, E., Rötzer, T (2014)). As the station furthermore focuses on the "experiment" as a step of the scientific method, the participants are instructed to conduct their own small experiment. They measure the height of a specific tree without using further material, than their own feet and thumb (Die Sendung mit der Maus. (2018)).

City Traffic

The station **"City Traffic"** is about the contribution of urban traffic to the emission of greenhouse gases. The participants learn that traffic is the main source of carbon dioxide in the city (Weiland, U. (2018)) and that it is therefore of utmost importance to reduce it as well as possible. To compare different means of transport they analyze the data of a fictive experiment by comparing costs, time need and carbon dioxide production (Verkehrsclub Deutschland e.V. (VCD). (2010)). This "Analysis of data" is the conclusive step of the scientific method.

The Scientific Method

The synoptic station **"The Scientific Method"** presents a short overview of all the research steps explained at the different stations on the trail (Bertemes,J.-P. (2013)), which are also displayed in figure 4. It also puts them into a comprehensive sequence, as the trail has no mandatory order. In a short quiz, the participants can repeat all they have learned about urban climate and the scientific method, which can help them to memorize it later.

Figure 4: Scientific Method

Initial Evaluation

Methodology

We tested the validity of our trail through an online survey conducted in the German language. Our original plans for a quasi-experimental survey design with students had to be canceled due to the COVID-19 pandemic. In particular, we asked participants to indicate on five-point Likert scales (1 = fully agree, 5 = fully disagree) to what extent they agreed with selected statements. The statements were: "I found the MUCtrail entertaining."; "I learned something about the scientific method."; "I learned something about urban climate."; "I like the graphic design of the MUCtrail."; "The texts are written in a way I can understand. "I found the selection of topics interesting."; "I am interested in further educational trails in Munich." Participants were recruited through our contacts and were instructed to browse through the trail app before filling out the survey.

Results

In total, 12 participants filled out the survey completely. The average age of the participants was 23.83 years, 58.33% were female and 91.67% had a university degree. The survey results are visualized in Figure 5 to Figure 11. In particular, all participants agreed or fully agreed that the MUCtrail was entertaining. Furthermore, a total of 12 and 9 participants agreed or fully agreed respectively with the statements saying that they learned something about scientific work and urban climate. Finally, 11 participants agreed or fully agreed with the statements, that the texts were easy to understand and that the selection of topics was interesting. However, when it came to the interest in further educational trails, the participant expressed a more differentiated opinion. Only seven participants agreed or fully agreed with the statement that they would be interested in further educational trails in Munich. In the free feedback section of the survey, some participants praised the trail (e.g., "Very well done, I enjoyed it!"). Other participants pointed out some graphical and spelling mistakes and provided advice for the further development of the trail (e.g. additional audio files).

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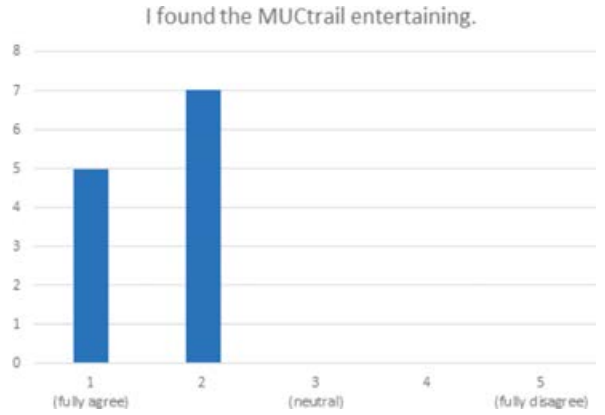
I found the MUCtrail entertaining.
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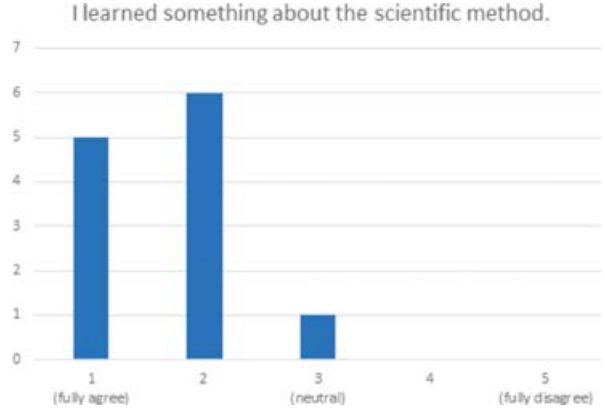
I learned something about the scientific method.
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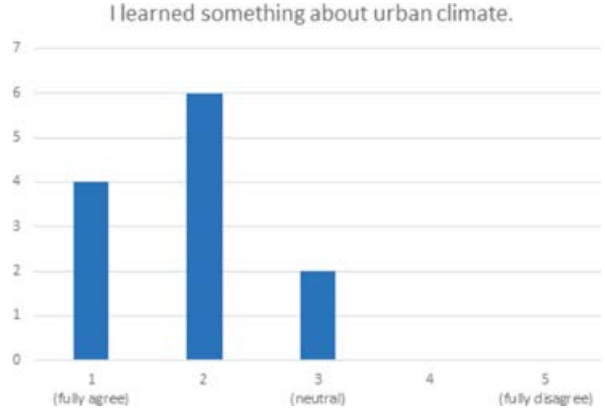
I learned something about urban climate.
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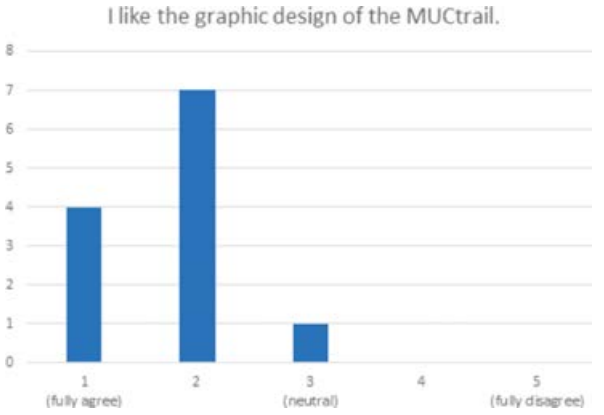
I like the graphic design of the MUCtrail.
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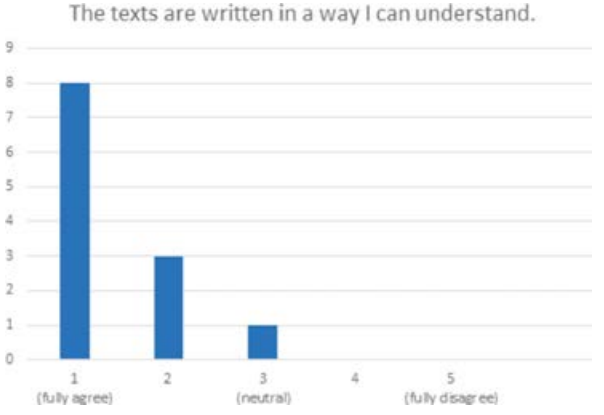
The texts are written in a way I can understand.
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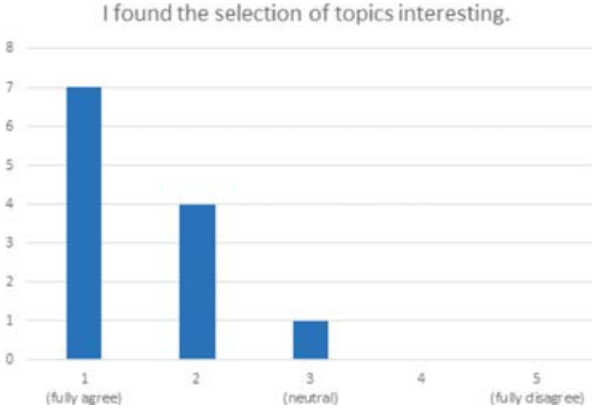
I found the selection of topics interesting.
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1 (fully agree)
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3 (neutral)
4
5 (fully disagree)

Figure 5 to Figure 11: Questionnaire response results

Discussion

Summary and Future Goals

Based on user feedback of MUCtrail, we have been successful in our goal of bringing awareness of climate change and the scientific method to people in a playful way. More than 90% of the participants found MUCtrail interesting and entertaining. More importantly, on an average, 87.5% of the respondents learnt about the scientific method in the context of urban climate. The interactive interface and graphic design made a positive impact on more than 90% of the MUCtrail users. Due to time constraints and resource limitations as a result of COVID-19, we were only able to achieve limited participation in the MUCtrail. The 12 participants had a university degree and were known to us personally.

In the future, we aim to survey a larger user sample with a more diverse educational and socio-economic background. The focus will be on students between nine to twelve years, which is our target group. This will help us gain more insight into the impact of MUCtrail on a larger scale and gauge the improvement in knowledge of the scientific method holistically. Furthermore, the design of the survey does not allow for causal conclusions, so experimental survey designs are promising research opportunities. Currently, the website is available only in German. We aim to make the website available in English as well. This will allow greater access to MUCtrail and increase awareness of science, scientific method and climate change worldwide.

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Self Reflection

At the Kick-Off event at Lake Starnberg the group of people interested in doing research about the interaction of science and society split into half and formed two teams, one of them being our team Munich Urban Climate Trail which was at that time called “Scienciety”. Unfortunately this first split wasn’t the last one our group experienced – in the first few months we had three members leaving the team for various reasons and one joining it. Though these changes made structured and productive working hard at first we could already settle on our target group – school aged children – and on communicating how science works as a goal. After our final team, consisting of Niklas Dreymann, Johaina Kullab, Nitish Nagesh, Beate Neu and Jessica Neusser, formed we could more intensively focus on developing an idea using the Design Thinking Methode as a guideline. In retrospect this was the most creative time of the whole journey and we had some pretty intense working phases, such as a Bootcamp at Niklas’ hometown Bad Sachsa, where we decided to create a science game as a final product. During this phase of generating new ideas, it was due to Niklas’ careful planning of our meetings and his overseeing our progress on our individual tasks, that we didn’t get lost in indecision. Johaina and Jessica did a great job in reaching out to potential collaborators, Nitish was taking good care of our posts and Beate elaborated the scientific background of the project. But as often in life inspiration didn’t come through great effort but in the form of a conversation with another teams’ member on the way home, who mentioned that he had always had great fun in learning stuff doing interactive adventure trails. Though this idea wasn’t completely new to us, this conversation facilitated our decision to pursue it, and after we made that call all the other tasks fell in place: in a natural environment of course the topic climate change would fit perfectly and for realising an adventure trail there weren’t too many potential collaborators. Afterwards there was a bit of exhaustion noticeable in the team – we had the feeling to be through the roughest stretch but the most of work for conceptualising and realising the actual trail was yet to be done. Most fortunately we won the Referat für Umwelt as a collaborator who could set us up with an existing platform for creating our trail in form of a Web-App. To elaborate the content of the trail each team member was focussing on a different topic. This was necessary to gain enough expertise, but slowed our working progress also significantly down because we were focusing more on ourselves than motivating each other. And even after we had a better idea on what each station should look like it took us more time than anticipated to find a designer to draw some sketches for us and someone to read our text for final corrections. Being so focussed on the trail itself we neglected the scientific side a bit. It had always been the greatest challenge for us, as none of us had much knowledge of how research in social sciences is properly conducted and it was therefore more than obvious that it was not our area to shine. In March 2020 the Coronavirus pandemic imposed a further threat on our research as it became clear that in the close future there would be no opportunity to have pupils participate in our trail and measure the impact it had on them as we formerly planned to do. Very recently the measures to prevent the spread struck us again when the event to present our trail to the public was postponed to spring 2021 (safety first!). The last couple weeks of the program felt like the last miles of a marathon – we had to add some final touches but our minds were already dealing with new and exciting developments in our lives. Now that we look back on our time in TUM: Junge Akademie we remember the personal effort it cost each of us, are proud of our achievements and genuinely happy to have stepped up to the challenge.

Acknowledgement

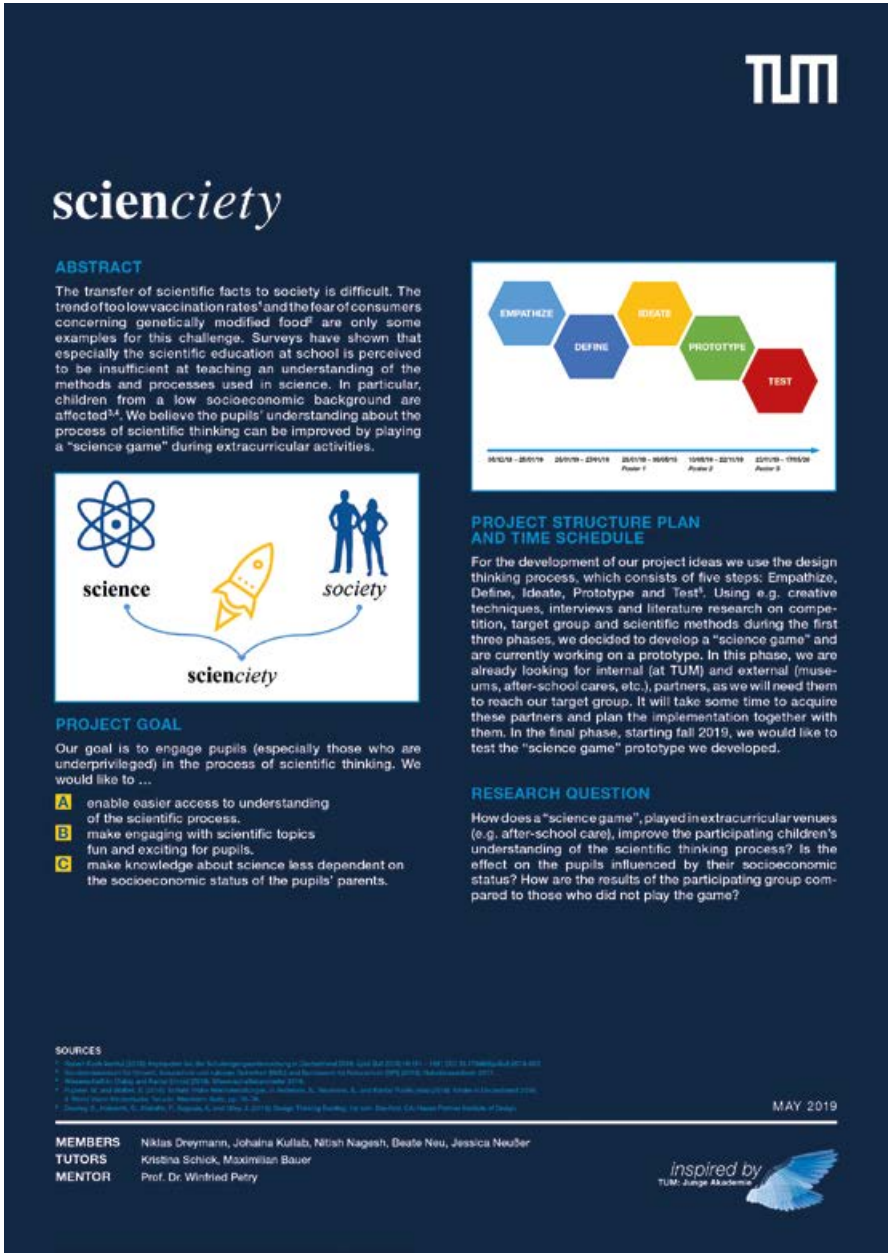
We would like to thank all the members of the TUM: Junge Akademie family for this enriching experience. We thank Prof. Müller for his vision and inspiration during the entire program. Peter Finger supported us during the whole journey from the start till the end, always patient and energetic. Maria Hannecker was the sweetest person we could talk to and she was always ready with her enthusiasm to help us during the workshops, seminars and individual discussions.

Our tutors, Kristina Schick and Maximillian Bauer, were supportive and encouraged us to think outside the box. Their inputs helped us implement the project better and in a more scientific way. Prof. Petry, our supervisor, encouraged us to think scientifically and provided the initial direction required for our long term project. We thank the lovely Junge Akademie office assistants for maintaining constant communication and ensuring timely submission of posters, reports and milestone progress.

We immensely benefited from the scientific writing workshop provided by Dr. Weitze along with constant updates regarding the project report form Constanze. During this 22-month long journey, the workshops conducted were the most exciting and enriching. We thank Dr. Alexander Lang, Matthias Lerner, Stefan Röhrl for their insights on project management. Elizabeth Raes and her colleague helped us in developing our team canvas to stay on track and together during the project duration. We also thank members of the different taskforces, especially Events, for organizing visits to museums, ballets, operas along with the running dinner and photography sessions.

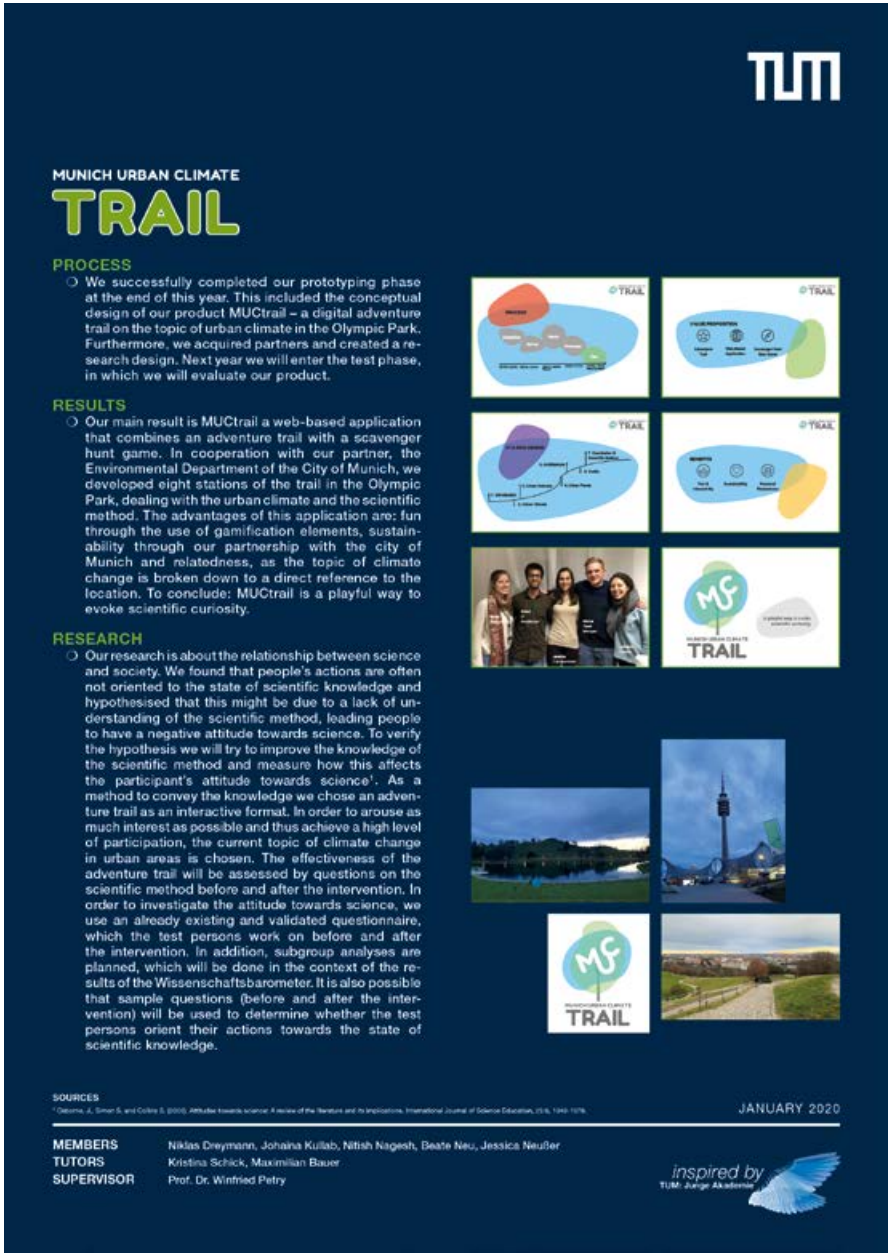
Our collaborators at the *Referat für Umwelt* we genuinely thank for providing the perfect platform to launch our trail and their expertise and flexibility in realising it. We are especially grateful to Moritz Monninger and Franziska Naumann who we could always approach with our suggestions. We would also like to thank Isabel Boergen for correcting the text for the Web-App and making it more suitable and fun to read for children. The designers, Ulrich Leyermann and Reiner Stolte, breathed life into our graphics, posters and the Web-App allowing enhanced visual appearance and aesthetics.

We thank our friends and family for answering questionnaires, providing useful inputs regarding existing gaps in science communication and supporting us throughout this wonderful journey. We apologize if your name is not mentioned here and you have interacted with us in any way. We remember you in our hearts and dedicate this to all of you and to the society for the betterment of science.

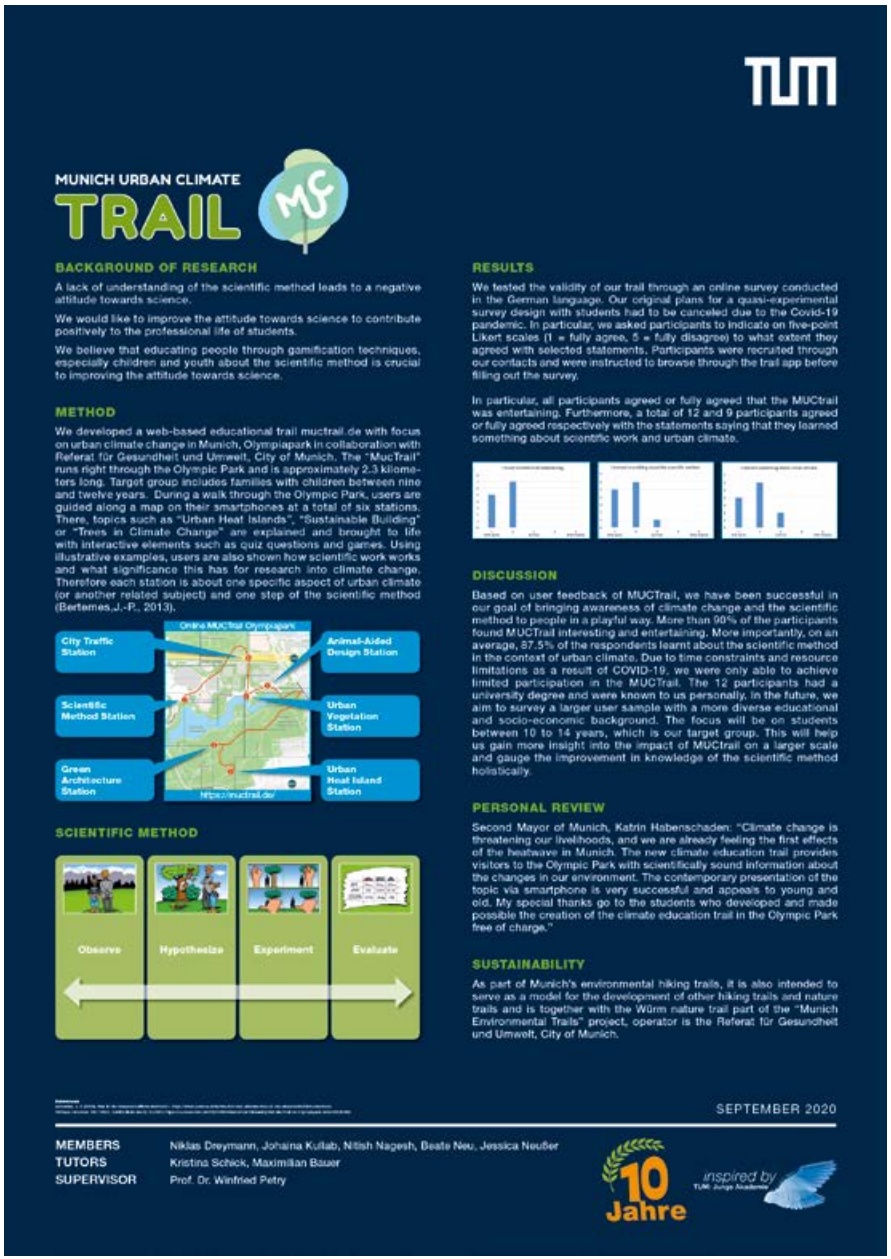


POSTER 1: We had our first kick-off at Generali Academy near Lake Starnberg in November 2019. We chose our teams and topics. We as a team decided to work on bringing science and society closer to each other and called ourselves "Scienciety." Armed with project management tools from the workshops conducted at Generali Academy and Bad Tölz, we developed a project structure plan and time schedule. We adopted a design thinking approach with the following phases – Empathize, Define, Ideate, Prototype, and Test. We then developed our initial hypothesis and set our project goals. The main goal was to enable an easier understanding of the scientific process, especially among pupils. We then conducted a literature review and developed our initial research question. We then communicated our findings at a workshop in Haus der bayerischen Landwirtschaft, Herrsching.

POSTER 2: After communicating our hypothesis and research question, we gained an insight into science communication and ethics in science at a workshop conducted in Haus der bayerischen Landwirtschaft, Herrsching. With more project management inputs at our disposal, we moved forward in our design thinking phase towards creating a prototype. We decided to develop a science game for schoolchildren to help them learn more about the scientific method. We wanted it to be a fun and interactive learning experience. We tinkered with various prototypes at the TUM Makerspace at Garching. Finally, we zeroed in on creating an adventure trail to educate children about climate change in Munich. We contacted many partners, including Deutsches Museum, Munich's environmental department, and an adventure trail in Freising. Based on factors such as sustainability, long-term impact, and resource efficiency, we partnered with the City of Munich's environment department to create a new adventure trail to educate children about the scientific method.



POSTER 3: Based on our evolved aims and goals, we renamed ourselves Team MUCTrail (Munich Urban Climate Trail) in the workshop held at the Akademie Schönbrunn in Gut Häusern. We incorporated the principles of good research practices taught at Vollmar Akademie, Kochel am See into our project. After creating the initial prototype, we finalized our project as an attempt to promote scientific curiosity in a playful way. We designed a digital adventure trail based on urban climate in Olympiapark in partnership with Munich's environmental department. We developed six stations to educate children about the scientific method. The scientific method comprises observation, followed by hypothesis, then testing the hypothesis with experiments, and finally analyzing the data obtained. The stations are designed to inform users about a number of different aspects related to the urban climate. They include urban heat islands, urban architecture, inter-relationships between man and animal, urban traffic, and urban vegetation. At each station, there is an explanation of the phenomenon followed by quizzes to develop critical thinking in children and educate them about the changing environment dynamic in Munich. The last station summarizes the entire trail and teases the brain with insightful questions about the scientific method.



POSTER 4: As COVID-19 struck, our discussions moved online, and the final presentation was delayed. But with our indomitable spirit, we continued marching forward to create an adventure trail accessible to all. After designing the stations, we partnered with a graphic designer, Ulrich Leyermann and Reiner Stolte, to bring our stations and logos to life. We aided Franziska Neumann in creating the muctrail.de website. The website walks users through the different stations while educating them about the scientific method. The trail serves as a tool to improve the attitude of children towards science. Our project accomplishes "multimodal communication," which was the theme of our project year, in a fun and interactive way.

Our adventure trail was inaugurated on September 25, 2020, by Katrin Habenschaden (second mayor of Munich, Bündnis90/Die Grünen) and Prof. Dr. Gerhard Müller (TUM) at Olympiapark. We sent questionnaires to children and assessed their knowledge about the scientific method before and after using our online adventure trail. We noticed that both children and parents were now more aware of the harmful impact of climate change. They were more informed about the scientific method and vowed to take steps to reduce their carbon footprint in Munich and around the world.