
StreetScience

Project Report **StreetScience**

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Management and Communication of Knowledge

Within the projects of the TUM: Junge Akademie, students learn, in interdisciplinary groups, systematic project work on an exemplary socially-relevant scientific topic in preparation for their future professional practice in a permanently changing world. Our project group has been formed with the topic "Management and Communication of Knowledge" in mind. It was clear from the outset that, within this very broad area, a more specific and delimited project had to be defined. The project group had set itself the goal of finding new ways to achieve more public interest in science and the students of the project group discussed ways to develop a new format in which scientific results could be conveyed to a wider public.

After thorough discussions of various options, the students proposed the idea of presenting interesting areas of TUM research at an information booth at the Munich Street Life Festival. The Street Life Festival is a street party in Munich that has been organized since 2000 by the environmental organization "Green City." Core topics are environmental protection, healthy living, urban design and renewable energies. The Street Life Festival is held twice a year, on a weekend in early May and early September. Its many showplaces attract numerous visitors. In recent years, about 250,000 people have visited the festival on each occasion. With its comprehensive technical equipment and infrastructure and its relaxed atmosphere, it offers ideal conditions for dialogue with the public and the organization of an interesting supporting program. People visit the festival for entertainment and the idea was to attract people to the TUM booth by offering entertaining presentations of serious scientific research and thus encouraging a greater interest in TUM research and a broader understanding of its significance. The students set themselves the goal of increasing awareness of the importance of public knowledge via public engagement of TUM scientists and of disseminating knowledge and raising enthusiasm for knowledge in wider circles of society. Research should be understood and made comprehensible in its meaning as a well-founded scientific activity, yielding consolidated and well-founded scientific knowledge. For the project group, the scientific aspects of the project consisted in the conception, planning, and execution of the event and, in particular, the systematic evaluation of the audience's reaction.

The idea was implemented through the conception and realization of the StreetScience event, in which scientists directly reported on their research at first hand. The first StreetScience event took place on Munich's Leopoldstraße as part of the Street Life Festival on May 5 and 6, 2018. For this purpose, and in a good location, a 50m² TUM-flagged tent with information booths and benches was built for the public.

The project group was able to attract an impressive number of TUM scientists to give presentations. Worth mentioning here is the enthusiasm with which renowned TUM scientists agreed to participate, as well as the fact that they then invariably captivated their audiences with their excellent performances. The TUM scientists had one hour each for their presentations. This time was filled with demonstrations, short lectures, and answering questions from the audience. The selected format very effectively engaged the interest of the audiences while also clearly conveying the scientific subject-matter. Children were welcomed and were encouraged to learn playfully from small experiments.

For the project work, a hypothesis was first established and this provides the basis for a systematic evaluation. This evaluation will consist of two questions:

- Did we reach the desired target group with the event?
- Did we achieve the desired effect with this method of knowledge transfer?

Questionnaires were prepared for the StreetScience events in May and September. By ascertaining the socio-demographic characteristics of the visitors, it was determined whether the visitors at the stand constituted a representative sample of the general population. The qualitative comment fields allowed for an evaluation of both the speakers and the event. There were also questions facilitating the evaluation of the event's impact on the audience.

With the development of the event format for StreetScience, the Group "Management of Communication and Knowledge" has performed excellently and has demonstrated its ability to cooperatively and creatively execute an interdisciplinary project in an impressive manner. We strongly suggest that this StreetScience event should be continued and developed further by TUM in the coming years.

The task of the mentors and tutors was to share experience and knowledge with the students to help the progress and success of the project. The mentors guided the students through sensitive leadership and supported them as much as possible in developing their ideas, both on their own and within the group work. As the project progressed, the students made excellent progress and finally carried out the project completely independently, achieving a really impressive result.

At present, the systematic and scientific evaluation of the project has not yet taken place.

Ernst Mayr and Peter Russer

How to escape the ivory tower

To tackle the crucial problems of the future, further advances in science will not be enough.

It is necessary for society to reconsider its behavior in accordance with the correct measures predicted by scientific methods. This process would need a general consensus on which predictions we can trust and which we cannot. The term "alternative facts" used by the U.S. counsellor to the President Kellyanne Conway showed the audience one thing clearly: Acceptance of opinions over fact, of emotional judgement over scientific knowledge is on an all-time high. Science has always been humanity's best tool for searching for objective truth. However, trust in the method and in the community that wields this tool has decayed in the last half century. To re-establish trust in the scientific method and community, it is not enough to communicate new knowledge. It is also crucial to reduce the perceived distance between society and science and to involve both in a process of integration. Society into science and science into society.

Science Journalism

Currently science, from our point of view, still seems to be communicated from within an ivory tower. Scientists are isolated and generally not considered to have the experience to communicate to the broad public in an understandable way[1]. Here science journalists have found their niche. With a talent to simplify and contextualize information, and sometimes even a scientific training, their ability to explain scientific research and results to non-scientists is high. Additionally, they partially take over the publics responsibility to serve as controlling instance to the scientific process. Still, if the underlying problem is mistrust in the scientific process or the scientists conducting research, relying purely on science journalists is not the solution. Having a herald bringing notice from the ivory tower of science may inform, but not build up trust in the scientists inside.

Scientific rock stars

Not all scientists are isolated from the public. Through digital media and hosted on various TV-channels, certain scientific rock stars have emerged. Some mostly communicate about their own general field, like Neil deGrasse Tyson or Stephen Hawking. Others go beyond their personal research field and are expected to have a scientific viewpoint on all topics that concern society. Bill Nye in the U.S.A. and Harald Lesch in Germany are two such scientists who are held to act as experts for all scientific fields.
Scientists in comparison to journalists have a better understanding of the scientific process and can inspire future generations to take careers as researchers or simply to keep interested in current scientific discoveries. But, as with science journalists they still lack the expertise and experience when it comes to fields in which they do not have their own research expertise. To rely on figureheads of science has its own disadvantages for science communication. First, a few scientists cannot cover all scientific fields in a depth that can inform and nurture a public debate over the newest scientific results. Second, even if we had a single all-knowing scientist, the amount of people that this voice of the scientific community can interact with is limited by the method used to communicate. In this case, science communication has to take place though the mass media, and this does not allow for all individuals in the audience to have a true dialogue with the scientist. Lastly, as with all rock stars, the trust is bound to the individual. Problems arise when the aim is to foster trust in science through popular individuals. Trust in one specific scientist still allows for distrust in results that come from other scientific sources. And when such a rock star of science is caught communicating wrong or inaccurate information due to him not being infallible, the whole trust put into science by his "fans" might be put in jeopardy.

New places and new communicators

Single scientists or journalists using mass media are not the only way of communicating science to the broad public. Institutions like schools or museums have done this for a long time. When it comes to science communication schools are not the place where the newest scientific discoveries are communicated. Museums on the other hand cover long existing scientific research as well as many exhibitions with findings that were made in the last few years. Although they are crucial for informing the public, they mostly lack opportunities of talking directly to the researching scientist and are located in places exclusive to the purpose of science communication.

1 National Academies of Sciences, Engineering, and Medicine (2017), *Communicating Science Effectively: A Research Agenda*, p. 12

When trying to tear down the image of scientists sitting in an ivory tower, it is not enough to roll out the red carpet from the main entrance. The nobility must interact with the commoners and do this outside of their intimidating halls.
The approach to be taken here is twofold. First, science communication has to be based on mutual interaction between the researching scientist and members from the audience. This allows the public to ask questions no one can answer as precisely as the true expert, but also is, according to the National Academies of Sciences, Engineering and Medicine, "an important way to learn about the concerns, questions, and needs of the audience(s)"[2].

Integrating science into culture

Mutual learning, for the one about science and for the other about societal implications, generates benefits and trust on both sides. This is one step toward the ultimate goal of integrating science as part of a whole culture. Practicing science requires a specialist training and in that sense its practice will always be limited to a certain elite. But just as with music, theatre, cooking, movie making and more aspects of culture, lay people can enjoy and take an interest in science without practical expertise, and improve their lives by taking that interest. This societal view of science as part of general culture is even more desirable considering that science and technology more than any other part of culture transforms how we live our lives. As part of culture, science should not be reduced to the communication of findings. The process of how scientific discoveries are made and the personal motivation of researching scientists are just as important. Science has to be communicated by many researchers to have broad, high quality interaction between the public and science. The same conclusion was already drawn in 1985 by the Bodmer report which describes it as "each scientist‘s professional responsibility“[3]. This means many scientists have to be motivated to engage in science communication with the public. This is still hindered by the fact that institutions, especially in Germany, nowadays mostly reward them for high quality research and the number of published research papers and rarely for broader science communications.

Furthermore, new formats of science communication have to complement the old, taking the process outside the enshrined locations such as research institutes, museums or dedicated scientific venues. Invasion of cultural spaces can be done in many ways. Considering that science communication through direct interaction with scientists has the character of an event, many non-scientific venues that offer cultural programs can serve as a focus for these attempts. Markets, festivals and fairs in public spaces are ideal for such initiatives. In England science communication has already been adopted in such venues where the public might not expect to encounter science. For example, since 2011, "soapbox science" has been transforming pedestrian areas in England into speaker corners for scientist since 2011 and have spread in the past seven years over all continents. Events like "Markttage des Wissens" and our own event "StreetScience" in Germany have been organized to motivate their respective audiences to take part in new and old formats of science communication in novel locations.

Science communication is an old discipline that grew to adopt certain ways of communicating and certain types of communicators. To tackle the re-establishment of trust in science, new ways have to be found to advance the mission of disseminating scientific knowledge in society and to encourage society to view science as an integral part of its general culture. Science communicators have to find the right formats to communicate science in open, non-scientific venues and still preserve the idea that science serves the search for truth and advice for the public. The approach can only function if a large number of researching scientists are involved in the endeavor, which makes this transformation of science communication also a problem of how to transform the view of scientific institutions as to what their scientists should be rewarded for. ■

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2 National Academies of Sciences, Engineering, and Medicine (2017), *Communicating Science Effectively*: A Research Agenda, p. 25
3 Royal Society (1985), *Public Understanding of Science*

Scientific part

- StreetScience represents a format for science communication which embedded lectures, experiments and exhibitions of science at a leisure-oriented festival.

- Over both iterations of the event in May and September, we welcomed over a dozen scientists from TUM at the local Streetlife Festival Munich where they presented and discussed their research in front of roughly one and a half thousand pass-by visitors.

- Using questionnaires completed by visitors during the festivals, we were able to prove that the format generates interest, is independent of publicity, and attracts visitors who infrequently attend other events for science communication.

Strength:
- We were in general able to include topics from all subjects represented at TUM and to present them by varying methods.
- The composition of the team facilitated organization, given that each campus of TUM and different faculties were represented within the team.

Weakness:
- The implementation time for both appearances was very tight in relation to the period of the project.

Opportunities:
- The festival offers the opportunity to have large numbers of potential visitors at the same place without additional effort for the implementation of the project.
- Visitors do not need to plan to visit, which means one hurdle less for a visit than conventional formats. In addition, visitors are found in a relaxed mindset (compared to formats designated exclusively for science communication).

Threats:
- Due to the location at a preset festival, the availability of space for the event and the duration is limited.
- The Streetlife Festival offers multiple forms of distraction and unpredictable disruptions.

Lessons learned:
- The communication of science within a leisure-oriented festival is a chance to supplement conventional formats.

StreetScience – Reaching the unreachable? Embedding science communication in cultural events

Science communication is a vital element of scientific culture and even more relevant in these days of a more critical society. To reach people who are deemed outside of the range of conventional events for science communication we created a format embedded in a non-scientific event, the Streetlife Festival in Munich. The event attracts different sorts of visitors than comparable conventional formats of science communication. Additionally, the event creates a similar amount of "Situational Interest" as an exhibition at the "Deutsches Museum". The museum's validated scale was adapted and included in the questionnaire to have a comparable metric. Overall, an event was created that has the potential to be replicated by other institutions at other venues.

1. Background

1.1 Science communication – rising importance and ongoing problems

Since the early beginnings of science, the dissemination of knowledge[1] was an important driving force for the process of generating discoveries. Academic controversies about elemental contestations mostly within the scientific community formed the fact-based side of communicating science. The involvement of the society as a wider public for scientific insights took place in the form of cabinets of curiosities or similar approaches. These neglected relevant scientific backgrounds and the underlying scientific debates in favor of immediately perceptible effects [1]. A phenomenon still found today. During the 19th century, the commitment to communicating scientific insight increased and led to the emergence of popular science. In the expanding industry of print media, for example, the focus was increasingly on science. This trend was supported by multiple debates, including the question of the origin of life solved by Louis Pasteur and developments challenging the prevalent worldview such as the Darwinian theory of the evolution of life. Even scientists themselves contributed to such popularization, using the written word or open-lectures.[2] Alexander von Humboldt was one notable example – and the underlying motive was often to legitimize or finance oneself [2]. Indeed, the establishment of scientists as authorities increased rather than decreased, and the whole trend was reinforced by professional popularizers, like commercial publishers, scientific associations, science writers, and government agencies [1]. As the aim of popular science was questionable and the effects rather negative, the designation as "popular science" had a negative connotation. Consequently, a new name was established: "science communication," with the aim of communicating "fact-based" science as distinct from "popular" science [3].

One reason for the necessity of science communication was mostly based on the assumption that science is part of cultural socialization and should therefore be part of the basic literacy of the public.[3] A second reason was to create political legitimization based on the idea that a scientific education is necessary to be able to value the importance of science. This education takes place formally in schools and universities and informally in any other context [5].This reasoning is based on the assumption of an insufficiently literate public, later described as the deficit model. It holds that in order to compensate this deficit, it is necessary to increase factual knowledge in the form of a one-way process from the scientific world to the public. The evaluation of the success of the model was mostly performed by testing knowledge-based questions. Critiques described the results as indicators of "textbook knowledge," incapable of capturing the public attitude towards science, which strongly affects opinions on the public funding of research. Consequently, the focus of research switched towards the changing of attitudes and the understanding of science [6]. The overall goal of the following actions was summed up under the term of "public understanding of science" (PUS), which was coined and further defined in a report of the Royal Society [7]. The report not only claimed that the gap between society and the scientific world increased as a result of specialization, but also stated that as a consequence the

1 In this report, defined as "scientifically proven information"
2 The success of such lectures was already being questioned at the time by contemporary newspapers [1]
3 Defined as every person in society and, consequently, a very heterogeneous group composed of many different groups with different needs, interest and attitudes [4]

onus is on the scientist to try to work against this rift. Bodmer calls upon scientists to take responsibility for improving science communication in order to increase the understanding and acceptance of science in society, to improve attitudes to scientific topics, and to attract upcoming scientists. Nevertheless, the understanding persists that a well-informed society automatically draws the same scientifically correct conclusions as scientists. However, studies on the public attitude towards vaccination suggest that this can be challenged [8]. Despite improved sharing of information, no increase in the willingness for vaccination was found. It was shown that the opposite effect can occur and that in those cases, acceptance declined, or negative opinions were strengthened. The additional knowledge did not necessarily reinforce acceptance but sometimes also encouraged skepticism and uncertainty. This finding led to a paradigm shift in science communication before the turn of the millennium. The deficit model was exposed as incomplete and error-prone and replaced by a dialog-based approach, practiced under the term of "public engagement" [9].

1.2 The principles of Public Engagement

Ever since it was coined in the late 1990s plenty of different descriptions and definitions have been offered for the term Public Engagement (PE). From the United Kingdom, it has spread around the world and, with increasing proliferation, variations of the term have occurred. As we seek to encompass a wide range of benefits, the definition of the National Coordinating Centre for Public Engagement (NCCP) is applied in this study [10]:

"Public engagement describes the myriad of ways in which the activity and benefits of higher education and research can be shared with the public. Engagement is by definition a two-way process, involving interaction and listening, with the goal of generating mutual benefit."

One important aspect of the above definition is the focus on mutual benefit. We want to emphasize here that PE is in fact not a one-sided process but has been proven to have positive effects on every party involved [11-12]. At first glance, it may not be obvious how PE can be beneficial for the researcher. Yet, a growing amount of data and surveys suggests that PE is not only important but advantageous to the speaker [13], as the following aims and benefits of PE suggest:

- To inform and inspire the public: Researchers inform and inspire young people, adults and family audiences by sharing their research.

- To consult and listen to public views: Researchers become better informed about the public's views and concerns about their research, and also gain an opportunity to hear fresh perspectives and insights.

- To collaborate with the public: Researchers and the public work together on particular projects (citizen science) or help to define science policy regarding future research direction, policy or implementation of research outcomes.

The benefits for the public may be obvious but correlate closely with the aims of the communicator. There are five goals usually associated with PE: (1) to share findings and excitement about science, (2) to increase appreciation for science and thereby enhance legitimacy for science, (3) to provide information about specific topics to facilitate decision-making processes in politics or industry, (4) to change people's opinion on a given topic, or (5) to engage with the public to learn about its beliefs and perceptions.

There are multiple ways to achieve these goals but there is as yet no clear consensus as to which specific methods should be used or which have the greatest potential for success. A trial-and-error approach is still the most common way to define how to engage, where to engage, and with whom to engage [9].

1.3 Science communication and Public Engagement in Munich

To clarify the current situation regarding science communication in Munich we want to give a brief overview of the relevant existing projects and events. It is to be noted that mass media, social media and other parts of science communication not specifically related to Munich are not represented.

On the one hand, there are permanent venues, like museums dedicated to scientific knowledge such as the Deutsches Museum. These institutions present information throughout the year – mostly in the form of exhibitions. This limits the potential information gain to the presented content. Additionally, the degree of understanding is the perception depending on the visitor. On the other hand, there are projects which only take place on specific days in the year. For example, universities and other scientific institutions present their work on multiple occasions and at various venues during "Münchner Wissenschaftstage," and also during open-door days at their own facilities. Even public lectures take place, either in lecture halls or at other places, e.g. TUM@Freising. These institutional projects are complemented by smaller events, like occasionally science slams, "Wissenschaft im Wirtshaus," and science cabaret.

The shared pattern is that all of the events listed above take place in a venue associated with science or specifically designed to communicate science. Therefore, the majority of visitors are already genuinely interested in science. People with a low interest in science or those who may feel intimidated by science are less likely to be attracted. This raises problems if the whole population is to be reached by science communication.

2. Goals and Methods

2.1 Event design for science communication at the Streetlife Festival Munich

To engage with people of lower interest in science and those who might feel intimidated by dedicated scientific events, we created a venue for science communication at the Streetlife Festival Munich and employed it twice. Research conducted in the UK suggests, that science communication at generic venues can have an impact – largely because visitors are spending leisure time and are in a relaxed mindset [14]. Based on these findings, we created a booth at the Streetlife Festival Munich which was likely to attract people of all population groups and to facilitate the communication of science. First, it was stated that "simplicity mattered less than the opportunity for audiences to interact directly with scientists" [15]. Second, it was shown that classical formats of scientific presentation consisting of a lecture and a question-session have worked well in the context of similarly structured presentations on other topics. Third, the audience was able to understand challenging scientific issues [16]. Hence, we approached scientists from almost all fields of study represented at Technical University of Munich (TUM) and asked them to give short lectures including the opportunity for questions during and after the actual talk. To encourage the audience to engage and ask questions, a non-scientific moderator supported the lecturer. The lectures were held in a tent-like structure offering seating for around 30 persons. In addition, an uncovered area provided space for at least one exhibit visible from the far distance to help attract an audience. This meant that we could avoid classical methods of publicity and could make our event stand out more clearly from surrounding events. Furthermore, we offered the possibility – mainly, but not exclusively, to kids – of doing some small experiments, to handcraft platonic bodies or viruses, or to experience steps in the development of virtual reality glasses. The complete program is presented on our website [17].

2.2 Quantitative evaluation

The evaluation of our venue is divided into two subcategories. Primarily our evaluation consists of the testing of our initial hypothesis: "Science communication embedded in a public event can reach an audience that better reflects the public structure, in sociodemographic aspects, than an audience at an event that is primarily science-related." This is done in two phases, corresponding to the two iterations of our festival. The evaluation focuses on answering three general questions:

1. Do we reach the public, defined as a cross-section of the population in Munich?
2. Do we reach a section of the public that is further away from practicing science or cannot be reached by other known formats of science communication?
3. Does our science communication achieve notable short- and long-term effects as well as sufficient audience-holding power to contribute to a successful event?

The secondary part of our evaluation is the qualitative feedback from speakers, exhibitors and the audience. The feedback is crucial to the improvement of the event, as it gives insight into both the positive and negative experiences of all participants and can be used to further explore new scientific questions regarding the topic. The measurement was done by means of an anonymous questionnaire. Filter questions were used to determine the level of participation of members of the audience and to remove those who did not participate in our formats.

2.2.1 Sociodemographic analyses

The first part of our quantitative analyses tests our claim as to whether or not we reach an audience more representative of the public than other events. We measure the sociodemographic characteristics of our audience and compare it with the local population and audiences of other science communicating events and venues. More specific questions determine whether the audience has a higher pre-existing interest in science (e.g. because of an academic background) than the average population. Another question explores whether our audience visits other events or venues and consumes media that communicates science to determine if a large portion of our audience cannot be reached by conventional forms of science communication.

2.2.2 Pass-by visitors and degree of engagement

One of the reasons why we planned to communicate science in a non-science-related public venue is the attraction of visitors that do not expect to encounter scientists talking about their work. For one, up-front advertising is not necessary to attract visitors. Secondly, the pass-by visitors that finally attended StreetScience took this decision without having to drive to a specific science communication venue. For this reason, they might be different from visitors of other science communication venues.

Before the festival, a minimal amount of advertisement was done on various social media channels including those of TUM and other science communication events. This was asked for by various stakeholders in the project. To determine the relation of pass-by visitors to those that planned to visit StreetScience two yes and no questions were asked in the questionnaire:

1. Did you deliberately come to visit StreetScience?
2. Did you know about StreetScience from advertisement?

The four different combinations of answers that can be given to these two questions assign any visitor to one of four categories (see table 1). Category 1 contains the expected pass-by visitors. Category 2 are those visitors attracted by the advertisement. Visits from people in category 3 and 4 cannot be causally linked to the advertisement or the festival context. Visitors from category 3 may have needed the perception of StreetScience from another source like social media to have the impulse to visit StreetScience when they saw it during their general festival visit. Visitors from category 4 may have heard of StreetScience from another participant in another category.

Categories/Question	1. Deliberate	2. Advertised
1. Pass-by	No	No
2. Adv-Won	Yes	Yes
3. Adv-Immune	No	Yes
4. Secondary	Yes	No

Table 1: Classification of visitors to determine the impact of the advertisement.

In one question of the questionnaire, the visitors were asked about which activities they participated in. Visitors could indicate participation in multiple activities that were fixed on the questionnaire. These activities were not events on our program but a description of engagements possible at StreetScience. Further below they will be explicitly listed. In a second question, the visitors were asked to indicate if they agreed that it was interesting participating in the activities on a five-point Likert scale with the following options: “don’t agree at all”, ”don’t agree”, “neither agree nor disagree”, ”agree”, “totally agree”. This question served as a filter for two purposes: First, to filter out questionnaires of people who for some reason filled out the questionnaire without participating in any activity; and second, to filter out ratings of interest in an activity that people did not participate in and may have rated by mistake. The question that determined how strongly visitors agree that an activity was interesting served to determine which activities are important to get and keep visitors interested. To do this, an algorithm ranking activities based on ratings given by the same visitor was used. Not many visitors would participate in multiple activities and thus the interpersonal differences in how they rate the same degree of interest may give wrong results when averaging across all ratings given.

2.2.3. Our visitor at other venues

To determine if we reach an audience not captured by other types of science communication formats, we asked if our visitors had attended the Münchner Wissenschaftstage, any open day initiative at a scientific institution or events like “Lange Nacht der Wissenschaften” or “Lange Nacht der Universitäten” in the past two years. As a comparison, we asked the same about scientific museums and scientific lectures.

2.2.4 Determination of the situational interest by catch and hold analyses

Communicating science in the context of a street festival has similar goals as museums. Knowledge should be transferred, interest generated and to no specific audience but the general public. Museums are free-choice learning environments and the same can be said about science communication formats during a street festival. When trying to measure the generated interest in selected scientific topics, two types of interest can be distinguished: Situational interest and long-term interest. Situational interest is developed in a concrete learning environment [18]. It can be subdivided into two aspects: The catch-component describes the first appearance of situational interest when a person's interest is aroused and directed toward an issue. The hold-component describes the longer-lasting and stabilized situational interest, where a person wants to deal with a certain issue, learn more about it and perceives it as meaningful. In particular, the repeated activation of the hold phase is supposed to lead to the development of a long-term interest [19]. Situational interest has already been shown to be crucial when trying to reach a museum’s audience and is therefore also a realistic aim for our format.

To measure the generated situational interest during the festival, the questionnaire used a validated set of items with a five-point Likert scale [20-21]. The original scale contained twelve items in total. Six items each for both the catch-component and the hold-component. To reduce the amount of time needed to fill out the questionnaire and not to overload the visitors, the scale was reduced by eliminating some items. The catch- and hold-components are further subdivided, so the process should eliminate an equal number of items in all sub-aspects. Together with Prof. Lewalter, the creator of the scale, we eliminated the four items that were least important for internal consistency and reliability of the scale. This was done by identifying the item among the sub-aspect that, when removed, would have the least impact on the scales reliability, compared by using the Cronbach's alpha value [22]. Scales and data are closely related when it comes to reliability and the scale was not validated in the context we used it in. For this reason, we will recompute Cronbach's alpha value to judge whether or not the reduced scale is still reliable for evaluating a science communication format in a non-scientific environment.

2.2.5 Indication for a long-term effect

As previously mentioned, situational interest is only one of the two types of interest one wants to generate with science communication formats. Longer-lasting interest is the desired outcome and situational interest is supposed to lead to it [19]. However, measuring the long-term effect of science communication events is problematic. Rewards for participating in a long-term study have to be neutral so as not to further increase the selectiveness of an already highly selective sample consisting of people freely willing to participate in the studies. Handing out science-related consumables, such as entry tickets to a science museum, would have to be kept secret from the visitors until after they filled out the questionnaire so as not to influence participants’ intentions. In turn, this would mean that free entry tickets could not be used as an incentive to complete the questionnaire but could be used as a measure for generated longer lasting interest, by counting the number of redeemed tickets. Creating a large sample size would have needed a large investment. Hence, we focused on measuring only the situational interest as it is considered as a strong influencing factor on generation of long-lasting interest.

2.3 Qualitative evaluation of the assessment of visitors and speakers

When evaluating the effectiveness of science communication events scientifically, quantitative methods are not sufficient. Qualitative interviews are used to gain ecological and socio-economic information on specific conservation issues. They help to understand the knowledge, values, beliefs or decision-making processes of stakeholders, and strengthening research design and output as well as getting valuable feedback on how to improve the format. Although they are indispensable, their results and execution have to be discussed critically and transparency is needed on the sampling strategy and the choice of questions [23]. To meet these transparency criteria, the details of the interviewees and question selection follow.

To capture the feedback from the audience, we added two open questions at the end of the questionnaire. One asked for specific feedback regarding the presented topics, the exhibited objects and the program presented in order to gauge content-specific experiences. The other asked for notes, suggestions and critique to capture general improvement advice and emotion-based experiences. Every slot of our lecture program was followed by a debriefing of the speakers containing the qualitative interview where we asked all speakers the same nine questions. The first three focused on whether or not the speaker participated in other science communication formats, had thought that StreetScience was a valuable addition to these, and whether, after participating, their opinion had changed. The next set of three questions were intended to identify if the scientists who presented their work had benefited from participating. The questions ask if participating helped them understand the point of view and concerns the public may have with regards to their research; if they believed they had communicated important aspects of their work or had changed the visitors' opinions with regard to their research area; and, finally, if they felt they had something to take away for their own research and work. The last three questions asked for feedback on how helpful the moderation was, what they would change about the format of StreetScience and an open question for general comments.

2.4 Context-dependent limitations of the evaluation

StreetScience is implemented in the context of public non-science related events with an expected majority of pass-by visitors. For this reason, a questionnaire or interview has to be short enough not to scare off visitors during their leisure time. Equally, it is important to capture visitors with the evaluation once. Doing a separated pre- and post-evaluation is not feasible because a visitor would have to be asked to take time twice for the evaluation process unless one were to deploy a new type of evaluation that follows visitors throughout their visit of StreetScience. Gaining participants for a follow-up study is problematic as they would be either a special subset of visitors that were more positively inclined toward the evaluation subject or a subset motivated by a neutral reward offered to all visitors alike.

As of 2018, the collection of the necessary information for a follow-up study is even more problematic because of the newly established General Data Protection Regulation (GDPR [24]).

To argue about the effectiveness and efficiency of a new communication format, the comparison with similar formats is necessary. This, however, is only partially possible, due to big differences from established formats such as museums, for example, and the small number of executed studies in the context of more similar formats. Especially in the case of similar events that took place in some public context, no quantifiable metric was available. This led us to compare our format with museum exhibitions according to the established metric of situational interest.

When trying to compare similar formats to StreetScience one more limitation hindered us from answering more precise research questions: the unavailability of raw data. This allowed us only to compare StreetScience with the published results of other formats but not to answer more differentiated questions on the composition of visitors.

3. Outcome and Discussion

In this section, we will present the results of our qualitative and quantitative evaluation. By asking for the activities our visitors participated in, we were able to filter out questionnaires of those who did not take part in our format. From the 915 collected questionnaires, we were able to use 873 for further evaluation. The sociodemographic data will be compared with another event-type science communication format that took place in the same city. This will allow comparison with respect to city-wide estimates on the composition of its population [25]. For the comparison, we choose the Münchner Wissenschaftstage. This event is also a format trying to communicate science to the general public but taking place in different locations that require the audience to plan a visit to the event. The comparison was done with this format as our hypothesis expected StreetScience to have an audience closer to the sociodemographic average than an event located at more isolated venues. At the same time, a difference in the audience's profile is valuable too, as we shall see later, as this helps to engage a different portion of society.

3.1 Sociodemographic analyses

During the two events hosted on the 5th and 6th of May and the 8th and 9th of September, we used the same four questions to measure age, gender, highest acquired educational degree, and state of employment. For this reason, the results will be presented together and only relevant differences in the data will be presented. Such differences might exist because of the different seasons the two iterations took place in.

The variation for gender was negligible for StreetScience and Münchner Wissenschaftstage. When compared to publicly available estimates of the gender composition in society, StreetScience had a few more female visitors in May (f = 53.2 %, m = 46.8 %) and a few more male visitors in September (f = 47.7 %, m = 52.3 %), averaging out so closely to the estimate that the difference is only about 2 per mill. Although the Münchner Wissenschaftstage had a higher difference of 3-4 % from the estimate, the difference cannot be considered high either.

When measuring the age of our visitors, the option was to select age groups in spans of 10 years, e.g. "30-39 years old." The only difference was the group younger than 19 but older than 12. Children younger than 12 did not get the possibility to fill out the questionnaire but their visit was captured by a question asking visitors how many children of that age they accompanied. The collected data at every single iteration, as well as taken together, made us reject our initial hypothesis. StreetScience was not closer to the sociodemographic age average then Münchner Wissenschaftstage. As illustrated in figure 1, visitors at StreetScience were overall younger, with a significant spike in visitors younger than 30. In contrast, the Münchner Wissenschaftstage have a higher relative number of visitors between 40 and 80 than the estimated population. The average age in the estimate was 41.2. At the Münchner Wissenschaftstage it was 44.2 and at StreetScience 31.1. When computing the standard deviation of the relative number of visitors in every age group at the events to the sociodemographic average, the deviation at StreetScience (18.7 %) was even higher than at Münchner Wissenschaftstage (10.4 %). This, however, is still a result that can be argued to be good as a format was developed that takes place in a context were a different audience is reached.

With regard to employment types, StreetScience had significantly more students and fewer retired people and pensioners. This goes

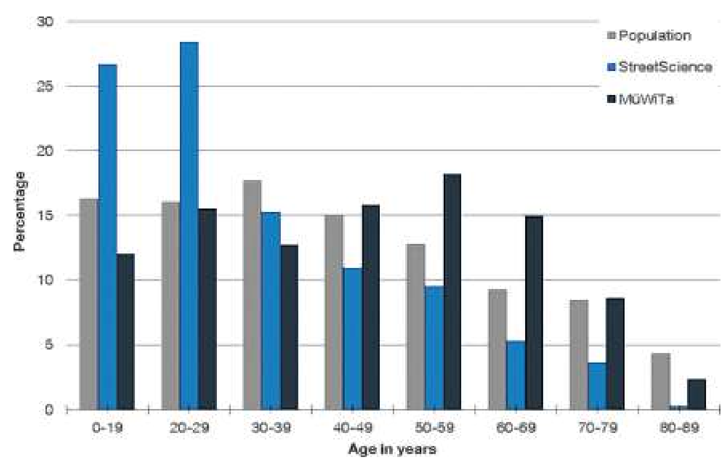

Figure 1: Age distribution of visitors from StreetScience in comparison to the Münchner Wissenschaftstage (MüWiTa) and the population of Munich.