

Project Report **CreaThesis**

Complex scientific work has a growing impact on daily life, and it is very important to communicate it in an accessible way. Yet, science communication is a skill that is often overlooked at universities. Team CreaThesis dedicated itself to question the current science communication between science and the public and aimed to improve the scientific communication skills of students via the use of art. Derived from studies which examined the impact of art onto the human brain and our perception, the idea was that creativity and art may provide additional support for a good research idea, innovative methods, and sound and understandable science communication.

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Preface by the Supervisors

Prof. Dr. Ernst W. Mayr and Prof. Dr.-Ing. Rolf Moeckel

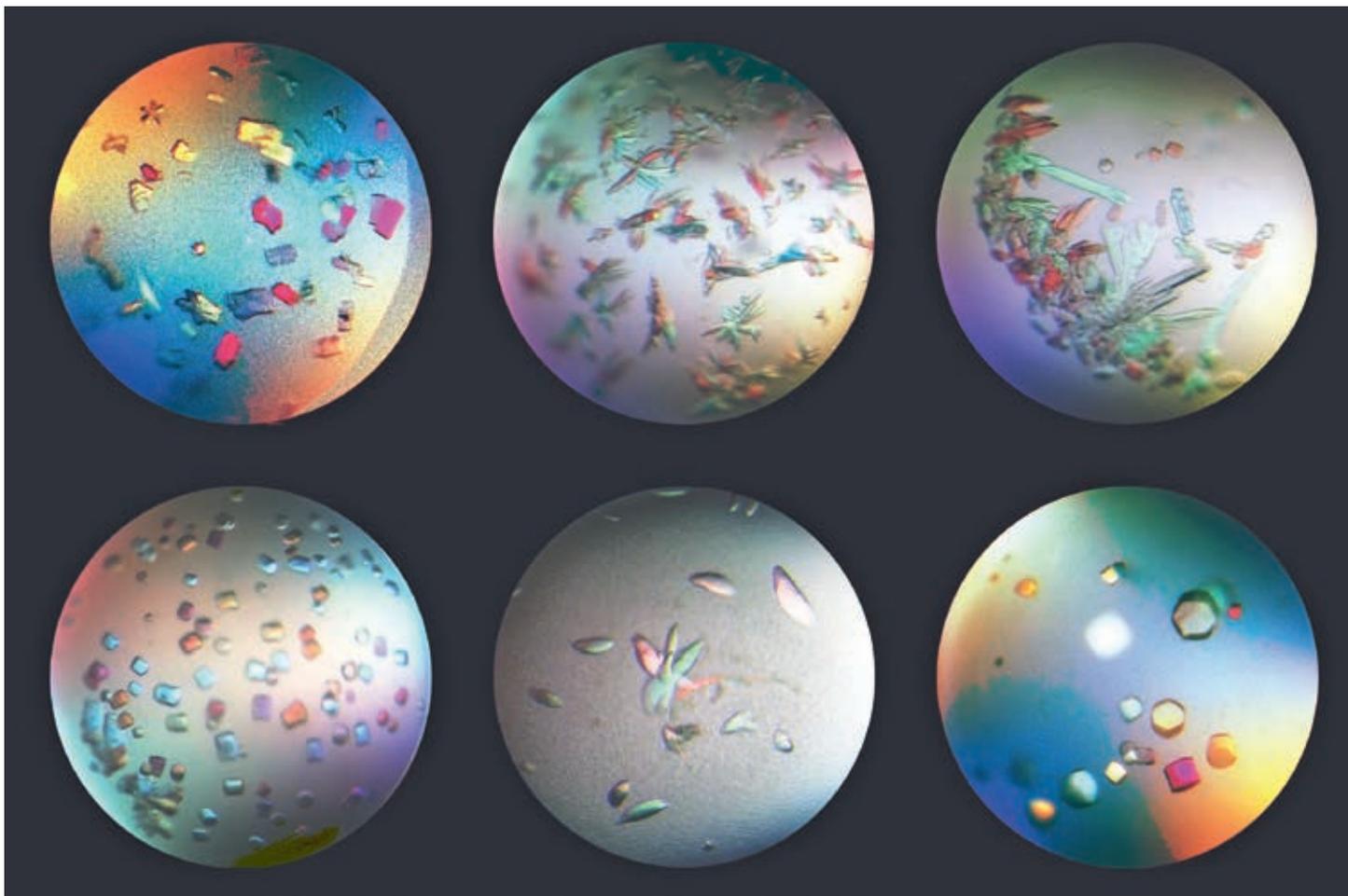
There is the widely held perception that scientists (more or less in all fields, and in the fundamental or natural sciences, in particular) do not communicate their work and their results in a commonly understandable language to the general society (which, quite often, is actually providing the financial support for this work). It should be clear that, given its complexity, much of the scientific discourse necessarily relates to intricate details, uses very special concepts, knowledge and language and takes place within rather small (scientific or related) communities. Obviously, such scientific communication must be precise, unambiguous and “technical” (actually, a fundamental postulate



and tenet for modern science). However, there are also some authors who communicate their findings poorly, with unnecessary jargon, getting lost in details and in needlessly convoluted language. While the complexity of science requires precise language, there are also very good reasons to search for ways to improve the communication of science, both between scientists and to a more general audience.

During the Middle Ages, there was a language issue. Science was available in Greek, Latin, or even Arabic, and most people in Europe did not know any of these languages or could not read them, or simply lacked the required background knowledge. In contrast to science, religion was communicated through the arts, including painting, sculpture, music and architecture. Art has been accessible in one way or the other to almost everybody, and this since very long times. It comes in many manifestations, a large number very independent of language, and (more or less) a communication channel open for most.

Thus, it is an intriguing idea to use the additional channels provided by the expression of art to communicate (impressions of) scientific work to a larger or different audience, less restricted by language or previous knowledge. A team of eight outstanding TUM students (all selected members of the TUM Junge Akademie program) established the CreaThesis project, whose goal it is to provide a framework and internet portal for all TUM students to make available to the general public more “artful” representations (possibly using alternative media) of their thesis work. The first examples implemented by the team suggest that art can open up to a much broader audience fields of research formerly accessible to a small research community only. This is scientific communication at its best! ■



A look into the crystals – The production of protein crystals for structure prediction.
CreaThesis of Theresa Franz

Science and Art do not fit together

By: Andrea Schittenhelm and Nico Michel, representing Team CreaThesis, Class 2021

Scientific communication is mostly done in one's own subject area. Therefore, scientists usually do not have to explain fundamental issues as simply as possible to reach the public with their findings. This situation has changed significantly during the last two years. In comparison to previous decades, the pandemic showed us that it is now more important than ever to communicate the most relevant research findings to the public and to explain their backgrounds.

The question is: does scientific communication have to change in order to reach the public with the most relevant scientific results?

Scientific articles typically appear as written text with few illustrations. They are rather inflexible because of their standardized structure for each and every research field – from architecture to zoology. A written text in an objective (if that is possible), flat, un-emotional style. It is just meant to convey data. It is meant to convey knowledge. It is meant to convey theories. The most important content is provided as simply as possible. No rehearsal, no rhyme. Seldom will you find suspense until the most important result is revealed. Do you still remember the content of a poem you learned at school? A song you sing by heart? It is easier to remember things that include some of these properties. However, reaching the public means to convey advice and information in a clear, reassuring, understandable and memorable manner. Notably, remembering information often means to have a story, emotional bonding, tension, or rhythm. What if we could write scientific content in blank verse, or construct information as songs are composed? Introducing new information in *strophes*; *bridging the strophe* with the main parts and hook the reader's attention.

If we answer this question with yes, how does the manner of communication have to change?

Maybe we should include a style of communication that has all these components naturally – like art.

Art can be playful, emotional, shocking, soothing, a picture, a painting, a text, a composition, a sculpture; 2D, 3D, 4D – in short: it could be a better communicator. A more flexible tool. Adapted for

everything - from architecture to zoology. Especially when it comes to science communication for the public. However, it is neither a general fix, a one-size-fits-all solution, nor is it conventional for science communication – yet.

To answer some of our many questions regarding this topic, we asked Professor Felix Mayer for his impressions regarding interactions between technical topics and art. The interview was carried out in German and later translated into English. We apologize for any loss of linguistic quality. For the original, see below.

CreaThesis: The founding motto of TUM is: "Scientiis et artibus" – "To the sciences and the arts" - Do you think that science and art are compatible?

Prof. Mayer: It is very welcome that the students of the TUM: Junge Akademie reflect on the concepts of "science" and "art." Thinking about what "science" means, how it should be pursued, and what role "art" plays in the life of every human being, is not only necessary, but should be thoroughly reflected upon by all members of the university, so that "Scientiis et artibus" is not just a somewhat sooty inscription on the facade of our beloved educational institution in Gabelsbergerstraße, or a slogan to be used in celebratory speeches.

Are science and art compatible? It is to misjudge the unity of the world if one considers science and art to be fundamentally different things that have nothing to do with one another or, at best, meet in design for product sales or as tools for science communication. We are always dealing with the world as a whole, whether we are aware of it or not.

It almost seems to me that in the words "Scientiis et artibus" the connecting "et" is the most important of the three words.

CreaThesis: In your opinion: what is the biggest similarity between science and art?

Prof. Mayer: Science and art are very human. That is also, but not only, meant as a compliment.

CreaThesis: In your opinion: what is the biggest difference between science and art?

Prof. Mayer: The formula $E=mc^2$ would probably have been written down also without Einstein, only a little later, and the double helix structure of the DNA would have also become scientific standard without Watson and Crick.

Of course, it is important when something happens, and the triumph of human thinking should not be diminished. But Frida Kahlo's paintings could only have been painted by Frida Kahlo, and by no one else; Marie A. could only be remembered by poor B.B.; and the choruses in "Idomeneo" could only have been composed by Mozart.

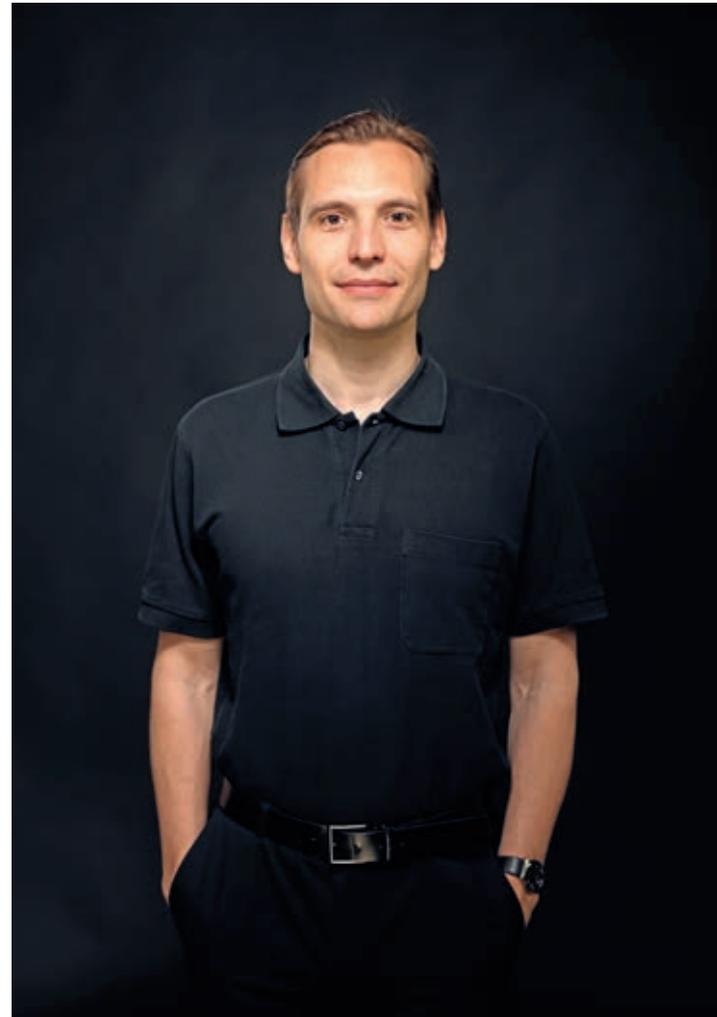
This is also connected with the fact that scientific striving and research is actually always considered under the reservation of provisionality. Even Euclidean geometry was supplemented by a later colleague with the strange name non-Euclid. Following generations will correct mistakes and interpret the world differently, they might possibly also forget correct and important things, as it is true for us in our time now.

But the paintings in the Lascaux caves, Beethoven's Ninth Symphony, or a recital by Jessye Norman are not provisional until something less flawed is developed or thought. That is a huge difference.

CreaThesis: How do you perceive the interaction between science and art?

Prof. Mayer: At this point, it seems to me that we have to specify *which* science and *which* art you actually mean. And *where*. In *which* faculty or school, in which museum, concert hall or streaming channel. And at what *time*. Now, instantaneously in 2022, or in the last 200 or 500 years. Operated by *which* scientists, scholars, and artists.

Without waiting for my follow-up questions to be answered, I answer in a very general and inadequate way, that at the moment – except in very technical art forms such as film or game development or, as already mentioned above, product design for the better salability of products – to me, it does not seem to be a particularly intensive interaction between "the" sciences and "the" arts. But it is very likely that I am wrong.



Prof. Felix Mayer Honorary Professor for Music at TUM since 2017, Department of Educational Sciences. He received a musical education in Germany and toured with orchestras throughout Europe. In 2012, he founded the TUM Choir and cooperated with the Münchner Philharmoniker. He teaches at the Carl von Linde-Akademie and is also a supervisor at the TUM: Junge Akademie.

CreaThesis: How do you combine science and art in your daily work?

Prof. Mayer: I cannot and do not want to separate science and art – and perhaps I cannot even combine them. I refer to my final sentence of the first question: It almost seems to me that in the words "Scientiis et artibus" the connecting "et" is the most important of the three words.

CreaThesis: Do you see the possibility that science may reach more people via a more artful presentation?

Prof. Mayer: Not only do I see this possibility, it also seems to me to be the only promising way forward.

But this insight is not new; Friedrich Schiller already wrote:

"From the mysteries of science, taste (beauty, art) leads knowledge out under the open sky of common sense and transforms the property of schools into a common property of all human society."

But it does not seem superfluous to me to point out that here, too, we have to ask ourselves which science is actually meant. It would be dangerous if we were to regard "science" per se as something basic and absolutely worth promoting. It is too human for that. Of course, this also applies to "art."

Art, with its powerful means, can also give prestige, respect, and validity to products of an overgrown science. And since

"science" primarily provides provisional results until they are refuted, scientific and pseudo-scientific achievements – I am thinking here of alchemy or astrology, for example – can acquire a false permanence through artistic means and cement prejudices longer than necessary.

CreaThesis: How do you evaluate the chances for art to be more involved in science communication in the future?

Prof. Mayer: If I get up in the morning on the right leg, I am hopeful and see opportunities; if I get up on the wrong leg, I am pessimistic.

But it is up to all of you, the young scientists, whether there is a chance for art to be more involved in science communication in the future. But as I repeat your question and write it down again, I have to confess that I don't like this formulation at all. I think it would be more of an opportunity for science communication, not for art, if art were to give science communication a little bit of a hand.

And since future developments are up to you, it's your job to expand and train your art appreciation and cultural literacy every day. ■

CreaThesis: Das Gründungsmotto der TUM ist »Scientiis et artibus« – »den Wissenschaften und den Künsten« – Halten Sie persönlich Wissenschaft und Kunst für vereinbar?

Prof. Mayer: Es ist sehr begrüßenswert, dass die Studierenden der Jungen Akademie über die Begriffe »Wissenschaft« und »Kunst« nachdenken. Das Nachdenken darüber, was »Wissenschaft« bedeutet und wie sie betrieben werden sollte und welche Rolle die »Kunst« im Leben jedes Menschen spielt, ist nicht nur notwendig, sondern sollte gründlich von allen Mitgliedern der Universität reflektiert werden, so dass »Scientiis et artibus« nicht nur eine etwas verwitterte Inschrift an der Fassade unserer geliebten Bildungseinrichtung in der Gabelsbergerstraße ist, oder ein Slogan, der in Festreden zur Verwendung kommt.

Sind Wissenschaft und Kunst vereinbar? Es heißt, die Einheit der Welt zu verkennen, wenn man Wissenschaft und Kunst für grundverschiedene Dinge hält, die nichts miteinander zu schaffen hätten oder sich bestenfalls im Design zum Produktverkauf oder als Hilfsmittel zur Wissenschaftskommunikation träfen. Wir haben es immer mit dem Weltganzen zu tun, ob uns das nun bewusst ist oder nicht.

Beinahe will mir scheinen, dass bei den Worten »Scientiis et artibus« das verbindende »et« das Wichtigste der drei Wörter sei.

CreaThesis: Was ist Ihrer Meinung nach die größte Gemeinsamkeit zwischen Wissenschaft und Kunst?

Prof. Mayer: Wissenschaft und Kunst sind sehr menschlich. Das ist auch, aber nicht nur, als Kompliment gemeint.

CreaThesis: Was ist Ihrer Meinung nach der größte Unterschied zwischen Wissenschaft und Kunst?

Prof. Mayer: Die Formel $E=mc^2$ wäre wohl auch ohne Einstein, nur etwas später, niedergeschrieben worden, die Doppelhelixstruktur der DNS wäre auch ohne Watson und Crick wissenschaftlicher Standard geworden. Natürlich ist es von Bedeutung, wann etwas geschieht, und der Triumph menschlichen Denkens soll nicht geschmälert werden.

Aber die Bilder Frida Kahlos konnten nur von Frida Kahlo gemalt werden, von niemandem sonst, an Marie A. konnte sich nur der arme B.B. erinnern und die Chöre im »Idomeneo« konnte nur Mozart komponieren.

Damit hängt auch zusammen, dass wissenschaftliches Streben und Forschen doch eigentlich immer unter dem Vorbehalt der Vorläufigkeit steht. Selbst die euklidische Geometrie wurde durch einen späteren Kollegen mit dem seltsamen Namen Nicht-Euklid ergänzt. Nachfolgende Generationen werden Fehler korrigieren und die Welt anders deuten, möglicherweise werden sie auch Richtiges und Wichtiges vergessen, so wie das für uns in unserer Zeit auch gilt.

Aber die Bilder in der Höhle von Lascaux, die Neunte Sinfonie Beethovens oder ein Liederabend von Jessye Norman sind nicht vorläufig, bis etwas weniger Fehlerhaftes entwickelt oder gedacht wird.

Das ist ein gewaltiger Unterschied.

CreaThesis: Wie erleben Sie das Zusammenwirken von Wissenschaft und Kunst?

Prof. Mayer: An diesem Punkt angelangt, scheint mir die Nachfragen überfällig zu sein, *welche* Wissenschaft und *welche* Kunst Sie eigentlich meinen? Und *wo*? In *welcher* Fakultät oder School, in *welchem* Museum, Konzertsaal oder Streaming Kanal? Und in *welcher* Zeit? Jetzt, augenblicklich im Jahr 2022 oder in den letzten 200 oder 500 Jahren? Betrieben von *welchen* Wissenschaftlerinnen und Wissenschaftlern, Künstlern und Künstlerinnen? Ohne die Beantwortung meiner Nachfragen abzuwarten, antworte ich ganz allgemein und unzureichend, dass mir derzeit – außer in sehr technischen Kunstformen wie dem Film oder dem Game Development oder, wie oben schon erwähnt, dem Produktdesign zur besseren Verkäuflichkeit von Produkten – kein besonders intensives Zusammenwirken zwischen »der« Wissenschaft und »der« Kunst besteht. Aber es ist sehr wahrscheinlich, dass ich mich täusche.

CreaThesis: Wie kombinieren Sie Wissenschaft und Kunst in Ihrer täglichen Arbeit?

Prof. Mayer: Wissenschaft und Kunst kann und will ich nicht trennen und vielleicht kann ich sie noch nicht mal kombinieren. Ich verweise auf meinen Schlusssatz zu Frage 1: Beinahe will mir scheinen, dass bei den Worten »Scientiis et artibus« das verbindende »et« das Wichtigste der drei Wörter sei.

CreaThesis: Sehen Sie eine Möglichkeit, dass Wissenschaft durch eine künstlerische Darstellung mehr Personen erreicht?

Prof. Mayer: Diese Möglichkeit sehe ich nicht nur, es scheint mir auch der einzig erfolgversprechende Weg zu sein. Neu ist diese Erkenntnis aber nicht, schon Friedrich Schiller schrieb: *»Aus den Mysterien der Wissenschaft führt der Geschmack (Schönheit, Kunst) die Erkenntniß unter den offenen Himmel des Gemeinsinns heraus, und verwandelt das Eigenthum der Schulen in ein Gemeingut der ganzen menschlichen Gesellschaft.«* Aber mir scheint der Hinweis nicht überflüssig, dass wir uns auch hier die Frage stellen müssen, welche Wissenschaft eigentlich gemeint ist. Gefährlich wäre es, wir würden »Wissenschaft« per se als etwas Grundgutes und unbedingt Förderndes betrachten. Dafür ist sie zu menschlich. Das gilt selbstverständlich auch für »die Kunst«. Die Kunst mit ihren mächtigen Mitteln kann nämlich auch Produkten einer verwilderten Wissenschaft Ansehen, Respekt und

Geltung verschaffen. Und da »Wissenschaft« vor allem vorläufige Ergebnisse bis zu deren Widerlegung liefert, können durch künstlerische Mittel wissenschaftliche und pseudowissenschaftliche Errungenschaften – ich denke hier beispielsweise an die Alchemie oder die Astrologie – eine falsche Dauerhaftigkeit erlangen und Vorurteile länger als notwendig zementieren.

CreaThesis: Wie schätzen sie die Chancen für die Kunst ein, in Zukunft mehr in die Wissenschaftskommunikation involviert zu sein?

Prof. Mayer: Wenn ich morgens mit dem richtigen Bein aufstehe, sehe ich hoffnungsfroh Chancen, wenn ich mit dem falschen Bein aufstehe, bin ich pessimistisch.

Es liegt aber vor allen an Ihnen, den jungen Wissenschaftlerinnen und Wissenschaftlern, ob eine Chance für die Kunst besteht, in Zukunft mehr in die Wissenschaftskommunikation involviert zu sein. Aber wie ich Ihre Frage wiederhole und erneut niederschreibe, muss ich bekennen, dass mir diese Formulierung überhaupt nicht gefällt. Es wäre wohl eher eine Chance für die Wissenschaftskommunikation und nicht für die Kunst, wenn die Kunst der Wissenschaftskommunikation etwas unter die Arme griffe.

Und da zukünftige Entwicklungen bei Ihnen liegen, ist es Ihre Aufgabe, Ihr Kunstverständnis und Ihre kulturelle Bildung jeden Tag zu erweitern und zu schulen. ■



"Scientiis et artibus" – "Den Wissenschaften und den Künsten": Das Gründungsmotto der Universität über dem Tor zum Innenhof.

Bild: Albert Scharger

CreaThesis

Abstract

In a world where science is exceedingly complex and has a major impact on everyone's daily life, it is more important than ever to communicate science in a way that is accessible to a wider public. Yet, science communication is a skill often overlooked at universities and research facilities.

In our project, we tried to find ways to strengthen this skill. We encouraged students to create an artistic interpretation of selected aspects of their scientific thesis, a *CreaThesis* that is accessible to people who are not familiar with the subject. To assess the development of their science communication skills, the participants answered a survey based on the science communication training effectiveness scale before and after creating their *CreaThesis*.

We then evaluated how the perceived scientific communication skills of the participants changed as a result of their participation in the *CreaThesis* project. Overall, we detected a nominal increase in oral presentation skills, expectations of a positive outcome, and science communication skills of the participants after they created their *CreaThesis*.

The results do not show statistical significance but indicate a trend that supports the hypothesis that creative presentation of scientific work increases perceived science communication skills. Our approach is thus worth pursuing further, taking into account its limitations and the barriers to participation.

1. Background

Scientific research has been practiced over centuries and improved constantly. Eisner and Powell (2002) argue that each practice can potentially be considered as art and that science and art are not dichotomous (Eisner & Powell, 2002). Like a mutual exchange, they positively inspire each other over a wide spectrum. The art in science has the ability to inspire, motivate, and enrich scientific work (Eisner & Powell, 2002).

But what is art?

It is hard to find a definition that captures all the different aspects "art" can *have, be, or produce*. The definition varies depending on who you ask. However, Hubert Ehalt (2009) gave a very elaborate explanation on the attributes of art during the Vienna lectures:

"The goal of the arts is to create pieces where shape and content form an indissoluble unity. [...] Art does not exist and has never existed; only the artwork exists." (p.16). And further: "In arts, the artwork emancipates itself from the artist. [...] There is this unwritten rule [that] the artists remain silent in regard to their work." (p. 18).

Many scholars have thought about art and its value. For example Goethe said: "one does not avoid the world so easily as through art and one does not interrelate with it so easily as through art" (Goethe, cited from Böhm, 2013, p. 35). The writer Colum McCann said that "art is one method to cope with the world by laying it under the microscope." (McCann, 2017, p. 83). Seeing art through the scientific lens, it was found that art (as music) is able to evoke emotions, increase engagement in spontaneous, self-referential cognitive processes and influence physical performance and regeneration (e.g., Bhattacharya & Lindsen, 2016; Taruffi et al., 2017; Thompson, 2009; Karageorghis et al., 2021). In regard to learning, there are even more forms of art that can help to encode and store information in the long-term memory. For example, writing a story, or drawing a picture, entailing information that has to be learned leads to (a) the generation of content and background, (b) a deeper elaboration, and (c) a rehearsal of the information, and, hence, to a more elaborate memory trace (Rinn et al., 2011). Furthermore, art production, in comparison to mere art perception, increases the functional connectivity in brain areas that are related to stress resistance (resilience) (Bolwerk et al., 2014). And does not everyone of us need more stress resistance?

But speaking about scientific facts of art – what is science?

Hubert Ehalt also gave a very elaborate explanation on the attributes of science during the Vienna lectures (2009):

"Research and science are processes of development [...] and the disclosure of new perceptions and ways of thinking. What was previously [state of the art] gets automatically a character of a "pre-stage". [...] "Sexy" means in science the most recent result. [...] In science, and especially in natural sciences, the main purpose is to find effects, functionality and their connection, obvious or obscure casualties [...]. It is essential that the theorem is correct, not beautiful. [...] This distinguishes art and science." (p. 17)

For our project, we mainly see art as a way of communicating. For more than tens of thousands of years, stories, paintings and pictures have been used to share information with a broader public. All these forms of art have in common that they are (to a certain extent) emotional, personally relatable, and exciting – attributes that are desirable for the general audience, but which are not necessarily included in scientific publications. There, the most important content should be provided as plainly and succinctly as possible. No repetition, no rhyme. Rarely, you find suspense. This is not a severe issue when scientists communicate with colleagues (science-to-science communication), as all the recipients are familiar with the rules and structure of a scientific publication, but it can become problematic if scientists want to share their results more widely, or even with the general public (science-to-public communication). What if we provide scientific information in more (and probably “better”) forms? What if we “[borrow] communication strategies from the arts [...]“? (Martinez-Conde & Macknik, 2017, p. 8127)

We hypothesize that creativity, and possibly also a version of art, provide additional support for a good research idea, innovative methods, and sound and understandable science communication.

As the above summary shows: one can find support for the assumption that art and science work best hand in hand. Therefore, our research question was:

Does the participation of students in CreaThesis increase the perceived science communication skills of the participants?

2. Goals and Methods

2.1 Goals

The main goal of our project was to improve students' science communication skills. In this context, we investigated whether the creative engagement of students with their own scientific work and the easily understandable presentation of the results would lead to a self-perceived improvement of their own science communication skills.

In addition, the project also aimed to achieve these further goals:

1. To give other students the opportunity to obtain an impression of research areas outside their own field of expertise and more generally stimulate scientific exchange through presenting the submitted creative contributions publicly on a website (<https://creathesis.ja.tum.de/>) and on social media.
2. Generate more attention for the scientific achievements of students.

2.2 Methods

2.2.1 Pilot Study Survey

To assess the acceptance of the project, we conducted an exploratory evaluation. For this purpose, we constructed a survey based on a 5-point Likert scale ranging from 1 (very low) to 5 (very high). A representative question used for the questionnaire is “Based on the description you read about CreaThesis, how high is your interest in participating”. With such questions we wanted to: (a) evaluate the interest of students in participating in the project; (b) determine which incentives we should provide that could support students' needs; and (c) find out whether students are interested in looking at the creative work of other participants.

2.2.2 Website Design

In order to present the contents of the CreaTheses created by the participants to the general public, we developed a website. This was designed by our team and hosted via the standard webhosting provided by LRZ. Participants were asked to submit a CreaThesis as a creative reworking of their thesis or an aspect of their thesis. They were asked to write a simplified abstract and to provide basic data about the thesis (name of the author, field of study, supervisor, chair). This information has been made available on the website (<https://creathesis.ja.tum.de/>).

2.2.3 Pre/Post-Test Survey

To investigate our main Research Question, “Does the participation of students in CreaThesis increase the perceived science communication skills of the participants?”, we applied a pre/post design which included two questionnaires. Prior to the intervention (i.e., creating a CreaThesis) we asked the participants to fill in the pre-test survey. The participants answered the post-test survey after the

intervention, that is, after submitting their CreaThesis. The goal of the survey was to measure and quantify students' self-perceived science communication skills. For this purpose, we adapted the *science communication training effectiveness scale* (SCTE) from Rodgers and colleagues (2020). The SCTE was designed to measure the effectiveness of science communication training. It has five dimensions: *motivation* (degree to which the participant is eager to learn new communication skills), *self-efficacy* (belief in being able to apply the new skill), *cognition* (acquisition of new knowledge), *affect* (cognitive representation of emotion), and *behavior* (goal-directed actions towards communication skill improvement). The authors used existing measures and modified them, as well as adding further measures. This led to a total of 17 items for the SCTE scale (Rodgers et al., 2020). The response format varies between 4-point, 5-point and 7-point Likert scales with different response possibilities (e. g. 1 = very insecure; 5 = very confident or 1 = not at all true; 4 = exactly true). As some of the items were not relevant for our purposes, we removed 31 questions in total from the original questionnaire. An additional 5 items were used to determine demographic variables as well as to understand how participants became aware of CreaThesis.

For the first part of the survey, we chose to include nine questions from the domain *self-efficacy* (e.g., "I can always manage to solve difficult problems in science communication if I try hard enough."), five questions focused on science communication and four questions focused on self-confidence during oral representations (e.g., "How would you rate your level of confidence in your ability to give a scientific talk to a lay audience?").

The second part of the survey focused on the dimensions of *cognition* and *affect*. The dimension *cognition* was used to determine whether perceived knowledge about science communication increased through the participant's own engagement with the topic (e.g., "My science communication skills make me feel well prepared for my next presentation."). The six questions chosen from the *affect* domain should provide insight into whether the participants have gained a more positive attitude towards science communication as a result of the intervention and are more satisfied

with their skills in this area. In general, the SCTE shows sufficient validity and reliability. However, as we altered the original questionnaire, the originally reported psychometric scale properties must be considered with caution.

2.2.4 Evaluation of the Website Data

To measure whether the submissions published on the website led to more attention for the participants' scientific results, the website data was analyzed using the Matomo Analytics tool. This allowed information to be collected on the number of visitors, visit times, and visitor behavior on the website while still using minimally invasive tools, protecting users' privacy.

3. Outcome and Discussion

3.1 Outcome

3.1.1 Pilot Study

The pilot study was conducted in May 2021 and revealed a high interest among participants in participating in the project (Number of participants $N = 108$, Median $M = 3.685$, Standard deviation $SD = 0.963$). The exact distribution of the interest in participation is presented in Figure 1. The study also showed that the participants preferred examples (87% of participants) and precise guidelines (64% of participants) to assist them in creating their own CreaThesis.

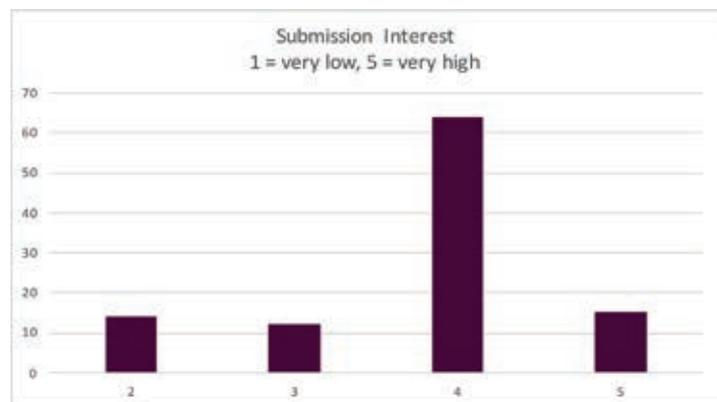


Figure 1: Distribution of the submission interest of participants found in the pilot study.

Regarding the support types, students were generally interested in different ones overall. Still, examples of CreaTheses and guidelines seemed generally more attractive to most than the support of art students. The exact results can be seen in Figure 2.

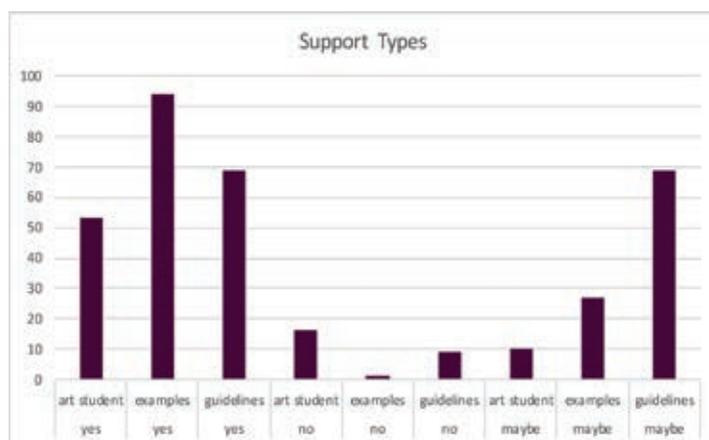


Figure 2: Distribution of the support types students indicated as preferences when creating a CreaThesis.

Finally, participants of the pilot study were asked about which incentives would motivate them the most to actually develop their own CreaThesis. Overall, it became apparent that students were not primarily motivated by monetary or other material incentives, but rather by intellectual curiosity, their possibility to learn something about science communication, as well as to use the participation as a highlight on their own CV.

3.1.2 Website

In October 2021 we were able to launch our website (<https://creathesis.ja.tum.de/>). The homepage can be seen in Figure 3. It contained information about our project and how to participate. CreaTheses created by the team were also presented to provide participants with an inspiration for their work. Each CreaThesis submitted by the participants was later presented on the website in a gallery format, seen in Figure 5.



Figure 3: Homepage of the CreaThesis website.

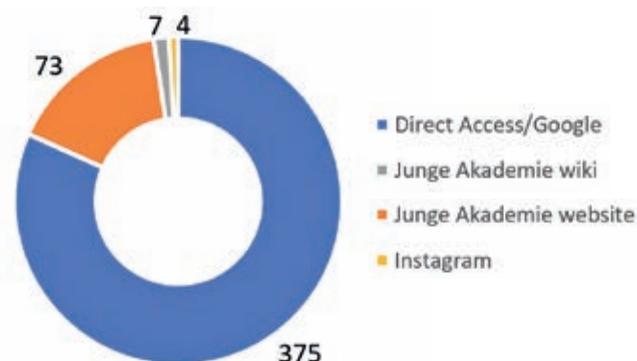


Figure 4: Access points to the website.

By analyzing the website data, it was possible to determine that our website was visited by a total of 461 people, with an average visit duration of 8 minutes. A large number of the visitors opened the website via direct access (Google, QR code, address entry) ($n=375$). The second largest group of visitors came from the TUM: Junge Akademie website ($n=73$) and some from the TUM: Junge Akademie wiki ($n=7$). From the Instagram channel, only four visitors accessed our website (Figure 4). The results point to a general interest in the project but also suggest that there were some barriers to participation or that the target group was wrong.

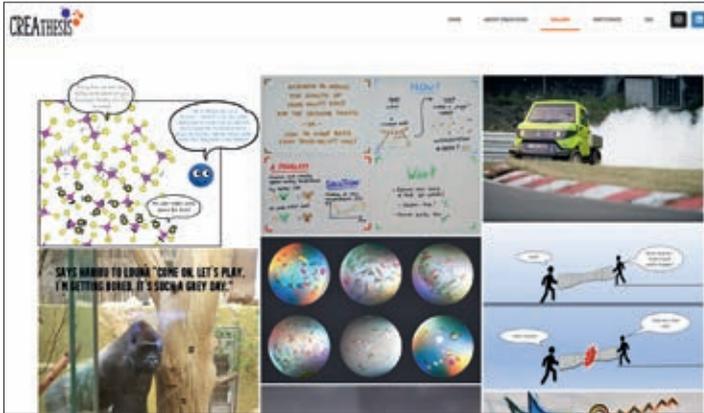


Figure 5: Part of the gallery consisting of CreaTheses designed for the project.

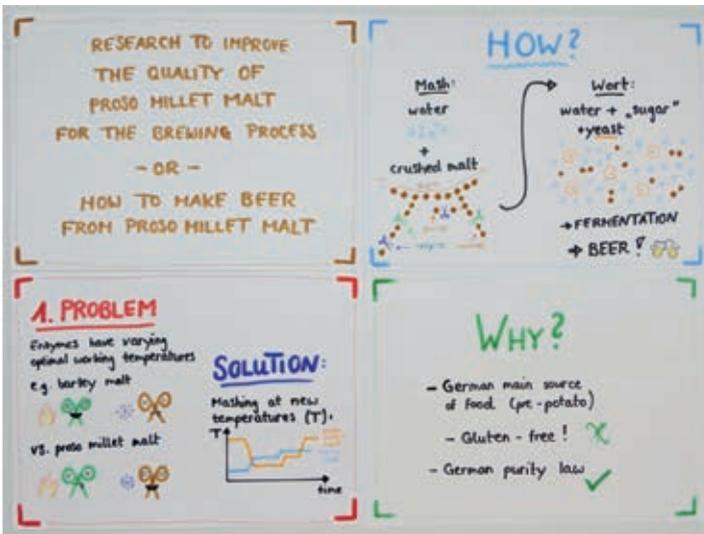


Figure 6: CreaThesis "Research to improve the quality of proso millet malt for the brewing process OR How to make beer from proso millet malt" by Magdalena Bader.



Figure 7: CreaThesis "Physical Unclonable Functions (PUFs)" by Veronika Bauer.



Figure 8: CreaThesis "The Integration of a new silverback male into a group of female gorillas" by Annika Neuhaus.

3.1.3 Submitted CreaTheses

The forms of artistic representation chosen by the participants were diverse and included photographs, sketches, schematics, and poems. They also covered a wide range of topics such as "Research to improve the quality of proso millet malt for the brewing process OR How to make beer from proso millet malt" (Figure 6), "Physical Unclonable Functions (PUFs)" (Figure 7), and "The Integration of a new silverback male into a group of female gorillas" (Figure 8).

3.1.4 Descriptive Results

A total of $N = 4$ participants handed in a CreaThesis and completed both of our surveys. The distribution of different descriptive variables can be found in Table 1.

Variable	Group	n	M	SD
Gender	Male	2	-	-
	Female	2	-	-
Age	-	-	24.75	1.71
Study Level	Bachelor	1	-	-
	Master	2	-	-
	PhD	1	-	-
Faculty / School	School of Life Sciences	2		
	Faculty of Mechanical Engineering	1		
	Other University	1		

Table 1: Overview of descriptive statistics.

Additionally, all participants were made aware of CreaThesis by friends or fellow students and said they were very likely to recommend CreaThesis to their friends (all answered 5 on a 5-point Likert scale). Likewise, one participant said he or she was likely to participate again, whereas three said they were very likely to participate again.

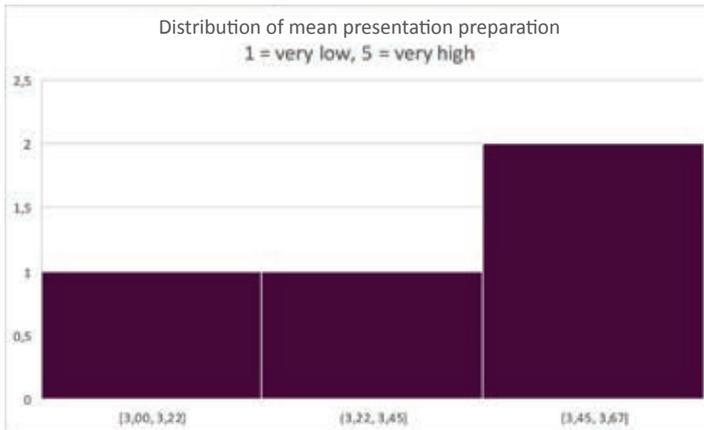


Figure 9: Distribution of mean presentation preparation.

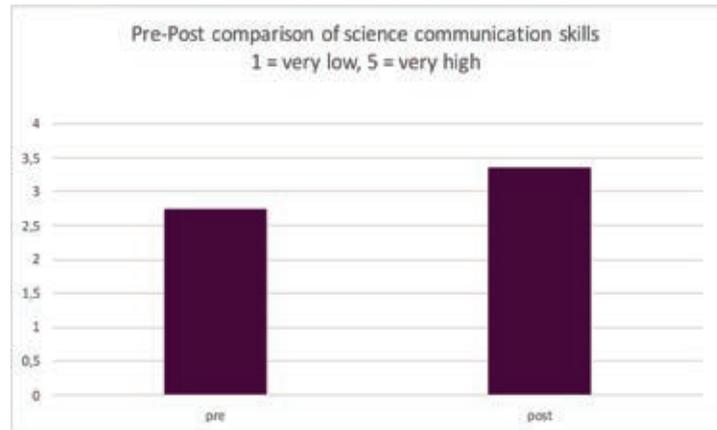


Figure 11: Pre/Post comparison of science communication skills.

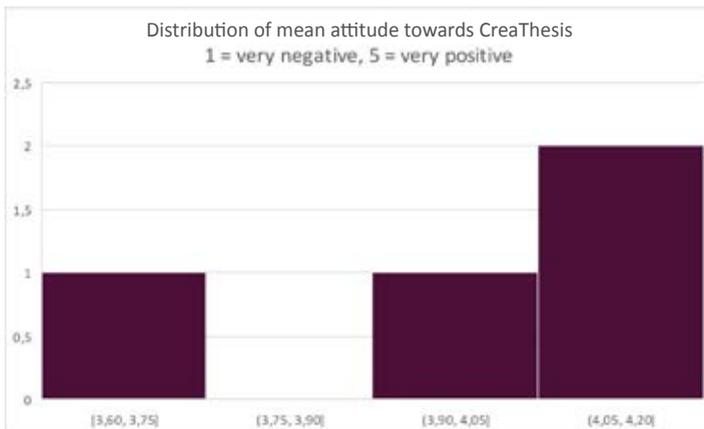


Figure 10: Distribution of mean attitude towards CreaThesis.

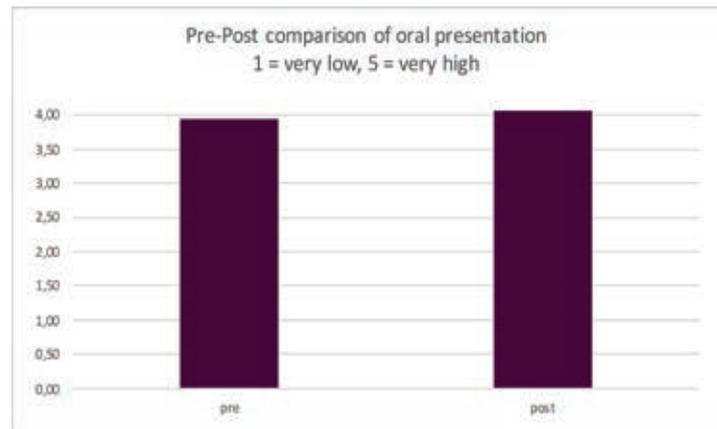


Figure 12: Pre/Post comparison of oral presentation.

Regarding the preparation for the presentation, most participants were medium to medium-high prepared as can be seen in Figure 9.

Further, most users had a medium to medium-high attitude towards CreaThesis as can be seen in Figure 10.

3.1.5 Pre/Post Comparison

All participants completed the same questionnaire before and after participation in CreaThesis. On average, the participants' belief in their science communication skills increased after participation in CreaThesis as shown in Figure 11. Before the participation, the average score was 2.75 ($SD = 0.53$), whereas it was 3.35 after participation ($SD = 0.1$).

Additionally, participants' beliefs in their oral presentation skills very slightly increased after participation (Figure 12). Before, they had an average of 3.96 ($SD = 0.315$), whereas they had an average of 4.06 ($SD = 0.125$) after participation.

Lastly, participants increased their positive outcome expectations in the participation of CreaThesis (e.g., "CreaThesis makes me stand out from my peers who are on the job market."). Here, the average before participation was 3.5 ($SD = 0.274$), whereas it was 4.07 ($SD = 0.378$) after participation (Figure 13).

3.2 Discussion

Based on the results collected during the project, we finally tried to evaluate whether the aim of the project, to improve students' science communication skills, had been achieved and whether the participation in CreaThesis did indeed increase the perceived science communication skills of the participants.

3.2.1 Data Interpretation

Although the results of the pilot study indicated a high level of interest in participation, the final number of participants was con-

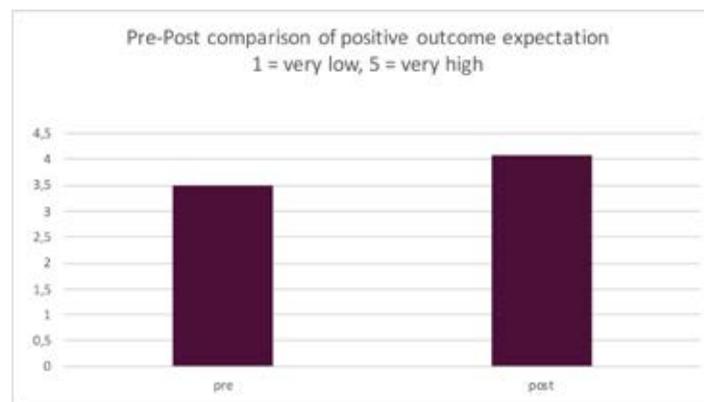


Figure 13: Pre-Post comparison of positive outcome expectations.

siderably smaller, with $N = 4$ at the time of evaluation. Possible reasons for this discrepancy will be discussed later. For the data analysis itself, however, this meant the evaluated results held no statistical significance. To achieve this, the number of participants would have had to be $N = 64$ ($d = 0.5$, $\beta = 0.8$, $\alpha = 0.05$). We could therefore neither confirm nor reject our hypothesis. Yet, we can look at our results and evaluate them in order to find a preliminary trend.

Overall, after creating the CreaThesis, participants rated both their oral presentation skills and their science communication skills higher than before participation in the project. This trend in the data supports our hypothesis that the participation in CreaThesis increases the perceived science communication skills of the participants. The participants also displayed a more positive expectation regarding the outcome at the end of the project compared to beginning. This indicates that their participation showed them that they are capable of handling such tasks outside their usual area of expertise and can achieve success here.

Regarding the additional goals of giving students the opportunity to obtain an impression of research areas outside their own field of expertise and to generally stimulate scientific exchange with our project we can see our website as an important first step. The platform is now available and gives interested students insights into different scientific fields and into the work conducted by other students in an accessible way. This increases the visibility not only of the research topic but also of the thesis written by the students. It also illustrates an alternative way to present scientific topics using unfamiliar means.

3.2.2 Limitations and Potential Improvements

While the results described above already emphasize the importance between science communication and creativity, a different project course was initially intended. This was in essence dependent on a higher number of participants. Several considerations are made as to why this number could not be achieved.

In the first place, it is assumed that many potential participants were deterred by the time involved in writing a CreaThesis. Unfortunately, there are no exact figures on the actual time required by the participants to create their CreaTheses. In particular, students who had not been creatively active recently might not have been able to confidently estimate the time required to complete a CreaThesis, which discouraged them from participating. Moreover, the low participation rates could be due to the fact that with CreaThesis a new offer was addressed to students, the added value of which could not yet be confirmed by a large number of experience reports. Thus, participation could have been a time-consuming risk for students, which they did not want to take due to the uncertainty of the resulting benefits. Various measures, such as the distribution of a participation certificate or a detailed description of how participation in CreaThesis can beneficially be mentioned in job interviews, were implemented to make it clear that this time investment could also be rewarded with potential benefits. In addition, monetary incentives were used. However, all of that did not appear to have been worth the time investment for most individuals.

A second aspect that may have had a strong influence on willingness to participate is the Covid-19 pandemic, which continues to this day. This could have been reflected in the fact that it was difficult to create the necessary visibility for our project among students due to an almost exclusive online presence. As there was hardly any face-to-face teaching during the project, fewer students were present at university facilities, and it was not possible to use physical advertising materials such as posters in lecture buildings. This is unfortunate, as, from such print materials, we had hoped for an influx of participants which we were unable to reach through TUM: Junge Akademie channels. Moreover, due to online lectures, most students have recently spent a lot of time alone in front of their laptops anyway, which may have made an online offering like CreaThesis even less attractive, since it would mean additional hours of working time with a laptop.

The third point to mention is that we collectively overestimated the motivation of potential participants based on the first survey. As a result, measures were derived that did not reflect the rather low level of interest in participating in CreaThesis among the student body. The very positive results of the first survey may have been due to social desirability, meaning that participants answered in a way they expected us to approve of. Furthermore, the general interest in and demand for CreaThesis, i.e., not only on the part of potential participants, but also on the part of potential consumers of the submitted CreaTheses, was overestimated. As a result, it was not possible to gain the desired level of attention for the project through, for example, word-of-mouth or sharing our advertising resources. This in turn had a negative impact on the appreciation and attention potential participants could expect for their submitted CreaThesis, so that this fueled the above-mentioned aspect of the insufficient benefits of creating a CreaThesis. Perhaps most students and other members of university and academia do not see the lack of interdisciplinary communication as a major problem, or our project effort was not sufficient to make them aware of it.

3.2.3 Project and Resource Management

One of the biggest setbacks was the lack of demand since we had to invest an ever-increasing amount of effort into marketing and recruitment. That could have been avoided by checking the demand more thoroughly. Even though an initial survey was conducted that showed promising results, we now believe that there was a response bias in the data that could have been reduced by finding a more heterogeneous group of study participants. We also should have insisted on a larger group of participants before continuing with our work. Being critical towards your own ideas and making strategic interventions throughout, especially after investing lots of time and energy, are some of the hardest but most crucial things to do. Another aspect was the overall project design. Instead of designing it around the needs of our participants, we constructed it in a way that was the most suitable for us.

Above all, we encountered real-world problems, made sub-optimal choices, encountered aggravated Covid conditions and had a too positive attitude towards our idea. Being more critical and trying to picture the project from an outsider's viewpoint would have helped to build an environment that would have fostered collaborative participation. Incentives are also often overlooked. We as scholarship holders already have an incentive to push forward with our project but that does not apply to prospective participants. Giving out ECTS credits or certificates of participation with a higher visibility would have helped to incentivize. Additionally, we scheduled meetings to discuss and delegate work that was then handled in subgroups or alone. Instead, we could have tried to schedule working sessions that doubled-up as meetings. That would have eliminated slack and would have led to a quicker response to problems within our project idea, while also boosting team coherence.

Another aspect that affected our lack of participants was marketing. A big takeaway for future projects is that there is no such thing as "too early," when it comes to marketing. Hang up more posters all over TUM, or in the light of the pandemic, exhaust the full potential of Instagram and LinkedIn marketing. As you can see from

our data, we were only able to funnel four users of Instagram to our website, which is a disappointing conversion rate. One could have contacted the TUM Instagram account or asked for a spot on the TUM website.

We also lost traction because our focus shifted to other side activities like applying to programs like the Deloitte Hidden Movers Award or dreaming of fancy art happenings with students of the HFF or ADBK. These sorts of activities do not help one's project while it is still in the design phase, but they do tie up important resources.

Finally, especially when dealing with projects that demand a fair share of self-initiative from students, live or in-person workshops can lower the "entry barriers". Workshops would have also helped to spread the word since they are recruiting and marketing measures all in one. Keeping in mind that workshops or events require preparation and planning that can not be done at short notice, such ideas need to be incorporated early on in a long-term strategy. So, start early and factor in drawbacks. Most things will require more resources than anticipated and as always: the devil is in the detail. Building a website and hosting it on the LRZ webspace took a lot longer than planned and posters or slide decks can not be designed overnight, just to name a few. Speaking of project management: it is advisable to build teams of two for important tasks such that the break of one person due to exams or vacation can be absorbed better.

4. Self-reflection

In terms of self-reflection, a deeper look at the internal processes within the team CreaThesis are worth mentioning. As such, the ongoing Covid pandemic not only presented a challenge in recruiting participants, but also had an impact on internal work within the team – eventually, behind a successful project stands a motivated and well-run team. First, working from home in isolation and the lack of communication in person had a negative impact on team cohesion and motivation for the project. Thus, the online meetings were very work-related and activities such as ordering food togeth-

er and socializing in the office, which were otherwise highlights of the TUM: Junge Akademie's daily project life in previous years, were omitted. Get to know each other, have fun and plan events. That will boost morale and motivation and will develop a long-lasting commitment to the team and project. Fun activities are what brings teams together. There was definitely a lack of social activities (mostly due to Covid) but even during times where rules were eased, the possibilities for reimbursed team events were rather small. In addition, getting to know each other digitally is often less intensive than getting to know each other face-to-face, and becoming comfortable with each other and trusting each other took longer at the beginning. Also, digital communication was sometimes less efficient than a face-to-face one probably would have been, which in turn made decision-making more time-consuming. Nevertheless, it should be noted at this point that there were no interpersonal difficulties or insurmountable conflicts within the group at any time.

5. Summary and Future Goals

Even though the obtained results from our survey were not statistically significant due to the low number of participants, it still provided us with valuable insights. The post-tests showed that participants had improved their perceived science communication skills after completing their CreaThesis. Even though results are, at maximum, qualitatively interpretable, they indicate a positive impact by our Project. Therefore, we really hope to have sparked the University's interest and wish that our idea finds its way into future projects of TUM's lifelong learning or Pro Lehre efforts. After all, students produce interesting papers every year and most of them are only read by a few people at best. Great works deserve a higher visibility which in turn would improve science communication, exchange and maybe even evoke curiosity in some future scientists.

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Self-reflection

von Andrea Schittenhelm und Nico Michel für Team CreaThesis, Class 2021

Note. The self-reflection is primarily a mirror of our thoughts, emotions, actions, and reactions. At some point also a journal entry of our meetings and team events. Therefore, we would like to present it in the original language of our operational mode. We hope you enjoy our language-based artwork – which was in this form only possible to compose in our mother tongue.

However, we tried to translate it with all its fine shades and shards of mirror fragments into English. You can find it below.

Vorwort zum semi-fiktiven Interview ohne Fragen:

Semi-fiktives – WAS?!

Das, liebe Leute, ist die *CreaThesis* von *CreaThesis*.

Abdrücke, Eindrücke, Fragmente vieler Augenblicke; Fetzen der Diskussionen, welche wir in den letzten 20 Monaten erlebt – oder eher durchlebt – haben.

Fein säuberlich zusammengetragen, gewaschen, getrocknet, zerpflückt und wieder neu zusammengesetzt. Der Anspruch an unsere *CreaThesis* war also kein geringerer als die künstlerische Gestaltung und Darstellung eines gesamten Projektes und dessen acht Mitgliedern.

Semi-fiktiv, weil wir keine Garantie dafür geben, dass die dargestellten Inhalte wirklich so in der Welt, die die meisten von euch als Realität ansehen, geschehen sind. Jedoch geben wir die Garantie, dass dieses »Interview« – die Einsicht in das Wechselseitige, das Dazwischen, das Nicht-ausgesprochene, das Zerriebene der Projektgruppe – zeigt, welche nachhaltigen Eindrücke das Projekt bei uns hinterlassen hat.

Viel Spaß!

Marlon ist noch nicht da. 3 Minuten warten wir noch...

Jetzt?

Also ich hab jetzt auch nicht nachgesehen, aber ich denke das sollte passen...

Hallo?

Ja ich hab das auch verifiziert. Die Tonaufnahme läuft.

Hören Sie mich?

Ja!

Ah, gut. Super. Also wie ich Ihnen gerade schon sagte, Nico, ich habe nicht viel Zeit.

Ja, dann mach ich mal den Anfang. Mir gehts heute gut soweit. Der Kopf tut gar nicht so arg weh. Ähm, meine Lieblingsblume... puh. Ich würde sagen, dass ist der Kaktus: Ist pflegeleicht und vertrocknet nicht so schnell. Und darauf freue ich mich im Sommer...chillen an der Isar mit nem guten Wein in der Hand.

Joa, mir gehts heute auch soweit ganz gut, bin an Staatsexamen Lerntag #3 angekommen, und habe schon keine Lust mehr – nur noch 97 Tage to go; yeah! Ja was mache ich am Wochenende, ich denke da mache ich erstmal frei.

Und meine Lieblingsblume – schwierig, ich mag so viele Blumen, da kann ich mich gar nicht so richtig entscheiden, ähm... die Pfingstrose!

Also mir gehts auch gut. Kam gerade vor 5min erst aus dem Labor heim und direkt ins Meeting. Blumen, joa also bei mir vertrocknet so die ein oder andere Blume gelegentlich mal, obwohl ich das ja eigentlich können sollte so als Biologe (*lacht*). Sommer, ach ja da steht dann die Masterarbeit an (*streicht sich die Haare aus dem Gesicht*). Also das sehen wir dann aber...joa.

Mir gehts auch gut so weit. Sitze an meiner Masterarbeit, keine Ahnung was danach aus mir wird. Burnout-Klinik? Dafür war ich heute morgen schon um 6 mit Tobi pumpen. Dank mir drückt er jetzt 5 kg mehr auf der Beinpresse. Und ich genieße jedes Mal Treppensteigen dafür, danke! Blumen, ich glaube die an meinem Fenster (*dreht die Kamera*), die ist schon 7-mal mit mir umgezogen und ihr gehts immer noch gut und blüht so schön. Sommer?! Endlich wieder in die Berge!

...Ja! Hallo erstmal an alle! Ich hoffe Sie können mich alle gut hören! Was war die erste Frage nochmal?

Ja. Ja (*seufzt*). Also, man musste sich ja letztendlich entscheiden. Also die Option jetzt ein komplett neues Unterthema aufzumachen, gab es ja nicht. Deswegen musste ich eine Wahl zwischen "Health" und "Science" treffen. Beide hatten Projektideen, die ich gut fand, aber eben auch Zeug, wo ich dachte, puh, muss das sein?

Hey Leute! Ich bin jetzt da. Um was gehts?

Ah ja! Ja das war eigentlich so, dass ich ja in "Business" war, aber dann sind die einfach gegangen und dann war ich da übrig und dachte, joa (*hebt die Schultern*), dann muss ich wohl was anderes finden.

Ja also ich hatte da eigentlich keine Präferenz, aber es schien irgendwie zu passen.

Weil es im ersten Moment nicht zusammenzupassen schien. Ja, ich denke da kickte einfach meine Liebe zur Nonkonformität.

Ja und Wissenschaftskommunikation ist jetzt auch nichts, was man vernachlässigen sollte, somit war das schon ein gutes Thema.

Ja, ja. Das mochte ich gar nicht. Aber was soll man machen.

Ick wollte da eigentlich auch nicht mitmachen.

Ich hatte wirklich keine Lust auf ein Online-Seminar!

Yeah - Team rote Corona-Warn-App...

Wir?

Ne, die anderen...

Achso.

Aber prinzipiell war es okay. Nur mehr Pausen wären gut gewesen.

Ich hatte wirklich keine Lust auf ein Online-Seminar!

Jaaaaa (*dreht den Kopf*). War nich so nice. Aber wir waren ja zu zweit, also dafür war es schon ganz gut. Und Nico hat frische Brötchen gebracht (*grinst*).

Ich hatte *wirklich* keine Lust auf noch ein online Seminar!

Das war eher...interessant. Auch ein wenig verstörend. Und sehr eng. Aber es hat unser Zusammengehörigkeitsgefühl auf jeden Fall gestärkt.

– **Erzählerischer Rückblick** –

Nico? Hallo? Hörst du uns?
JA! ICH KANN EUCH HÖREN!
Wie geht es dir?
ICH BIN FESTGEKETTET!
Was?!
ICH BIN FESTGEKETTET!
Siehst du was?
JA, DA IST EIN ROTES LICHT AN DER WAND!
Kommst du da ran?
DAS BETT FÄHRT HOCH!
Okay...
DAS LICHT IST AN!
Okay...
Weiß jemand was Knoblauchbrot hier genau ist?
(Stille)
Entschuldigen Sie, was ist denn alles auf dem Knoblauchbrot drauf?
Ähm, Brot. Und Knoblauch.
Ah ja...danke!
(Stille)
(Jemand prustet)
Schönes Gewölbe haben sie hier übrigens.

– **Erzählerischer Rückblick ENDE** –

**LEUTE! Wir müssen weitermachen,
sonst werden wir hier nie fertig!**

Achso ja, also das kam, weil Dr. Irber sagte, er sieht auf der Website acht schlaue Köpfe aber nur zwei CreaThesen...

Das war ree relativ schwierig und dann wieder nicht (*lacht*). Also wenn man dann mal was gefunden hat und eine Idee einen nicht mehr loslässt, dann probiert man noch 2-3x rum und dann hat man's eigentlich. Dann muss man nur noch den Hintern hochkriegen und den Text schreiben. Also wie bei der eigentlichen Thesis – ähnlicher Prozess würde ich sagen.

Im Prinzip hat es schon ganz gut funktioniert, ich mein, wir hatten von Anfang an gute Ideen, wir mussten uns dann nur für eine entscheiden.

Ja, also bei mir war es schwierig, jetzt wegen den Klausuren und den Daten für meine Betreuerin.

Bald. Ich hab einfach immer "bald" gesagt und das hat erstmal für ein paar Monate gereicht (*lacht*).

Ich hatte immer was im Kopf, aber an der Umsetzung... meine kommt sicher ein bisschen mehr als bald! Aber sie kommt (*hebt den Finger*).

Ja also ich hab ja keine Bachelorarbeit, ne, Leudde (*lehnt sich zurück und grinst*).

Also ich finde, dass haben Sie alle schon sehr gut gemacht. Ich hatte das auch nochmal an meine Studierenden weitergeleitet und denke, da kommt auf jeden Fall was zurück!

Leute, so am Rande, wir haben übrigens die erste Einreichung!

Wow! Hat die jemand angeheuert oder hat sie einfach so mitgemacht??

Peter hat auch gemeint er könnte da noch was einreichen. Man bräuchte vermutlich nur eine Horde wilder Designer die seine noch wilderen Ideen ordnen können.

Und wie lange warten wir dann auf eine Antwort von ihm? Weil public geht das Ganze nach Launch.

Uf jede Fälle bräuchtet ihr da noch was, dass des n bisschen au attraktiver wir' für de externe Eireichungen. Also des halde ich für ne gudde Idee.

Wir treffen uns eigentlich regelmäßig alle 2 Wochen. Von Anfang an. Auch an Weihnachten.

Ja, und wir waren auch immer vollständig.

Oh shit, ich bin nächsten Mittwoch in Berlin und weiß noch nicht ob ich abends dazu kommen kann.

Oder zumindest fast immer.

Ach shit, ganz vergessen zu sagen... Ich fahr gleich in Urlaub.

Sorry, ich habe heute Abend noch einen wichtigen Termin für die Arbeit!

Fast.

Auf jeden Fall brauchten wir noch einen Instagram Aufhänger und da haben unsere Marketing-Spezialisten die Memes erstellt. Daher die Postkarten. Und die Plakate!

Ehrlich gesagt hätten wir die Mülltonnen unter den Banksy-Schredder hängen sollen.

– Erzählerischer Rückblick 2 –

(Lautsprecherstimme): Ihr braucht was Rundes, um es dort aufzuhängen.

Hey Leute, sie hat gesagt wir brauchen was Rundes!

Ja, aber was?

(Lautsprecher stimme): Schaut mal nach einer Sitzgelegenheit...

Der Rollstuhl, der Rollstuhl!

Tobi! Wir brauchen das Rollstuhlrاد!

(Macht einen Wheelie) Oh, jetzt wo ich grad den Dreh raus hatte...

Ok Leute, wir haben Druck hinten raus, ich glaub heute wird's nichts.

Ich hab gerade hingeschaut und gelesen: "Problem: Biased Models. Solution: Blind Dating" und war leicht überfordert.

Ich dachte das waren die Schlussworte.

Don't destroy their dreams!

– ENDE –



Preface to semi-fictional interview without questions

Semi-fictional – WHAT?! – This, dear reader, is the *CreaThesis* of *CreaThesis*.

An imprint, an impression, fragments of many moments, scraps of the discussions from the last 20 months, which we have experienced – or rather underwent – and collected.

Nice and neatly gathered, laundered and dried, disrupted and reconstructed. Our claim for this *CreaThesis* was not lower than to create an artistic representation of the entire project and its eight members.

It is semi-fictional, as we cannot guarantee that the portrayed contents have exactly occurred in the world, which most of you see as reality, as it is written down here. But we do guarantee that this “inter-view” gives insights into the interactions, the in-between, the non-expressed, the pulverized, the grated of our project group; which shows the lasting impressions the project had on us.

Have fun!

Marlon is not here yet. So let's wait for another 3 minutes.

Now?

So, I haven't checked it either, but I think that should fit...

Hello?

Yes, I have verified that as well. The sound recording is running.

Do you hear me?

Yes!

Ah, good. Great. So, as I just told you, Nico, I don't have much time.

Yes, then I'll start. I'm doing well so far for today. The head does not hurt that much. Um, my favorite flower...phew. I would say it's the cactus: it's easy to take care of and it doesn't dry up quickly. And what I'm looking forward to in the summer... chilling by the Isar with a bottle of good wine.

Joa, I'm also quite well so far for today. I have arrived at the state examination learning day #three, and I am already bored by studying all day - only 97 days to go; yeah! Yes, what to do on the weekend... I think I'm taking the weekend off.

And my favorite flower - difficult. I like so many flowers, I really cannot decide. Maybe the peony!

I'm also doing well so far. I'm working on my master's thesis, but I don't know what will happen afterwards. Burnout clinic? But I was already in the gym with Tobi this morning at 6 am. Thanks to me he now presses 5kg more on the leg press. And I enjoy climbing stairs every time, thanks for that! Flowers... I think the one at my window (*turns the camera*). It has already moved 7 times with me, and it is still fine and blooms so beautifully. Summer? Finally, back to the mountains!

...Yes! First of all: hello to all! I hope you all can hear me well! What was the first question again? Could you repeat it please?

Yes. Yes (*sighs*). So, in the end, you had to make a decision. Since the option to open a completely new sub-topic didn't exist, I had to make a choice between "Health" and "Science". Both had project ideas that I liked, but also stuff where I thought, phew, does it really need to be like that?

Hey guys! I am here now. What is it? What are we talking about?

Ah yes! Yes, that was so that I was in "Business", but then some of them left the academy, and I was left alone there and thought, yaa (*raises his shoulders*)... then I thought I must find something else.

Yeah so, I didn't really have a preference, but it seemed to fit somehow.

Because at first it didn't seem to fit together. Yes, I think this simply kicked my love for nonconformity.

Yes, and science communication is not something that should be neglected, so that was already a good topic.

Yes. I didn't like that at all. But what should you do?

I didn't really want to take part either!

I really didn't feel like taking an online seminar!

Yeah - team red corona warning app...

We?

No, the others...

Ah!

But basically it was ok. Anyways, more breaks would have been good.

I really didn't feel like taking an online seminar!

Jaaaaa (*turns his head*). Wasn't nice. But there were two of us, so it was pretty good. And Nico has brought fresh bread (*smiles*).

I *really* didn't feel like taking another online seminar!

That was rather...interesting. Also, a little disturbing. And very close-by. But it definitely strengthened our team cohesion.

– **Narrative review 1** –

Nico? Hello? Can you hear us?

YES! I CAN HEAR YOU!

How are you?

I AM CHAINED!

What?!

I AM CHAINED!

Do you see anything?

YES, THERE IS A RED LIGHT ON THE WALL!

Can you reach it?

THE BED GOES UP!

Okay...

THE LIGHT IS ON!

Okay...

Does anyone know exactly what garlic bread is like here?

(*Silence*)

Excuse me, what's all on the garlic bread?

Um, bread. And garlic.

Ah yes...thank you!

(*Silence*)

(*Someone splutters*)

Beautiful vault they have here, by the way.

– **Narrative review END** –

**PEOPLE! We have to keep going,
otherwise we'll never finish here!**

Oh yeah, so that came up because Dr. Irber said he sees eight smart heads on the website but only two CreaTheses ...

That was relatively difficult and then again not (laughs). So, once you've found something and the idea won't let you go, you try around 2-3 times and finally you've got it. Then you just must get your ass up and write the text. Just like with the actual thesis - a similar process I would say.

Basically, it worked quite well, I mean we had good ideas from the beginning, we simply had to agree on one.

Yes, so for me it was difficult because of the exams and the needed data for my supervisor.

Soon! I just kept saying "soon" and that was enough for a few months (laughs).

I always had something in mind, but the implementation... mine certainly comes a bit more than soon! But it is coming (raises one finger).

Well, I don't have a bachelor's thesis yet (leans back and grins).

So, I think that you have all done very well. I had also forwarded this to my students again and I think, this time there is definitely something coming back!

Guys, by the way, we have our first submission!

Wow! Did someone hire her, or did she find us on her own?

Peter also said he could submit something. You would probably only need a bunch of wild designers who can organize his even wilder ideas.

And how long do we wait for an answer from him? Because the whole thing goes public after launch.

In any case, you still need something to make it a bit more attractive for the external submissions. So, I think that's a good idea.

We actually meet regularly, every 2 weeks. From the beginning. Also at Christmas.

Yes, and we were always complete.

Oh shit, I'm in Berlin next Wednesday and don't know yet if I can make it in the evening.

Or at least almost always.

Oh shit, I forgot to tell you... I'm about to go on vacation.

Sorry, I have another important work appointment tonight!

Almost.

In any case, we still needed an Instagram hook and that's where our marketing specialists created the memes. Hence the post-cards. And the posters!

Honestly, we should have hung the trash cans under the Banksy shredder.

– Narrative review 2 –

(Speaker voice): You need something round to hang there.
Hey guys, she said we need something round!
Yes, but what?

(Speaker voice): Look for a seating possibility
The wheelchair, the wheelchair!

Tobi! We need the wheelchair wheel!

(Makes a wheelie) Oh now that I just knew how to get
the hang of it!

Ok guys, we are under pressure, I don't think anything
will happen today.

I just looked and read, "Problem: Biased Models.
Solution: Blind Dating" and was slightly overwhelmed.
I thought those were the closing words.
Don't destroy their dreams!

– THE END –





CREATHESIS

WHAT IS CreaThesis ABOUT?

With our project *CreaThesis* we aim at improving science communication between the students of different scientific domains of TUM. Participants elaborate sub-aspects of their own scientific theses in a creative manner to generate something new: a *creathesis*.

There are no limits for the designs, the participants can express themselves freely and use techniques of their choice, e.g., painting, drawing, poetry, etc. *CreaThesis* is not about making professional art but about gaining experience in communicating scientific results to non-specialists and to raise awareness and create passion for research topics.

The unique form of publishing scientific results creates a high memorability, by which schools and departments can raise awareness of and draw attention to their research topics. Thereby, they can awake curiosity and enthusiasm for their work and thus recruit future students. Furthermore, this can promote exciting interdisciplinary cooperation.

OUR MOTIVATION

As science communication is a competence currently far too little practised, *CreaThesis* offers students a chance to train this skill. Importantly, we want to raise awareness of the scientific work conducted by students and to show appreciation for their passion.

OUR STRUCTURE PLAN.....

Concept	Market analysis	Process	Support	Creative work	Platform	Marketing	Public action
Project description	Market analysis	Legal framework	Literature research	Clear examples	Conceptual work	Contents identity	Register artworks
Stakeholder	Market analysis	Quality control	Attention on social media	Supporting videos	Implementation	Creative design	Public implementation
Evaluation KQ	Student survey	Submission process	What makes art interesting	Support of submissions	Testing	Integration	
	Statistical analysis		Research research		Launch	Advertising campaigns	
			Design creative work		Research		
			Artistic projects				

OUR TIMETABLE.....



MAY 2021

MEMBERS Alix Bertrand, Marion Demandt, Theresa Franz, Anita Kolmann, Nico Michel, Andrea Schittenhelm, Philipp Strobl, Tobias Tiemeier

TUTORS Sebastian Kaftenbach, Maximilian Wagner

SUPERVISORS Ernst W. Mayr, Rolf Mosackel



POSTER 1:

During the Kick-Off meeting, our team agreed that, contrary to general perception, science and art do not coexist as strictly separate fields, but overlap, interact, and often enrich each other. At the same time, we agreed that this fascinating relationship is rarely promoted in science and art education.

Based on this idea, we developed several outline proposals that would give the participants a new perspective not only on art, but also on their own field. We also wanted to give them the opportunity to expand their skills in an area that they were largely unfamiliar with and possibly apply these skills in their field later on.

One aspect we focused on quite early on was the field of science communication. On the one hand, it is of immense importance, but on the other hand, it is hardly ever promoted in science teaching.

Consequently, we focused on proposals that allowed us to combine these two topics and thus developed our final project idea: *CreaThesis*. In this project, students explain their often very interesting but rarely communicated theses in a way that even people outside their field can understand. To do this, they had to look at their own work from a new angle and design a creative, artistic elaboration, their very own *CreaThesis*.

Once we had finalized our idea, we developed an initial structure plan and timeline and got to work to make the project a reality. ■



CREATHESIS

WHAT HAPPENED SO FAR?

So far, a preliminary study has been conducted to assess the relevance of our project and to identify the push and pull factors for the participation among students. Based on the results, we started designing our website and creating the content. After completing some initial tests, the website is ready to launch. We also created our own *CreaThesis* to provide orientation for our participants. Our marketing team has prepared content to start our campaign. The questions for our scientific survey have been compiled.

OUR RESEARCH QUESTION

Does the participation of students in *CreaThesis* increase the perceived science communication skills of the participants?

OUR FIRST RESULTS

Our survey revealed many interesting insights into students' opinion in *CreaThesis*. While many of them helped us in fine tuning our efforts, the graphs on the bottom show the two most important ones. First, students rated their submission interest on a 5-point likert scale ranging from 1 (very low interest) to 5 (very high interest). As can be seen clearly from the graph, most students seem to be interested in participating in *CreaThesis* ($M = 3.685$, $SD = 0.963$). (see [figure 1](#))

FIGURE 1

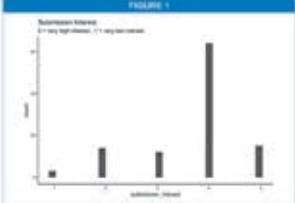
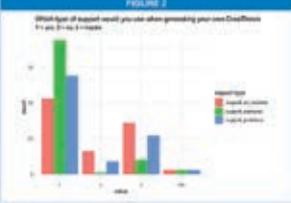


FIGURE 2



Additionally, we needed to identify the most important types of support that students would make use of in order to further increase the likelihood of participation. Here, examples of how a *CreaThesis* could look like (**87% of participants**) as well as precise guidelines (**64% of participants**) have been found to be the most relevant types of support we need to offer. (see [figure 3](#))

ADAPTATION OF OUR APPROACH

Originally, we intended to conduct our survey not only with participants who had created a *CreaThesis*, but also with another group that had created a classic poster and compare the results for these two groups. Ultimately, this poster group proved irrelevant to answering our research question and was therefore removed from the research plan.

References:
 1. Schmid, M., & Schmitt, J. (2019). The impact of digital communication on the scientific communication of research results. *Journal of Science Communication*, 48(1), 1-15.
 2. Schmid, M., & Schmitt, J. (2019). The impact of digital communication on the scientific communication of research results. *Journal of Science Communication*, 48(1), 1-15.
 3. Schmid, M., & Schmitt, J. (2019). The impact of digital communication on the scientific communication of research results. *Journal of Science Communication*, 48(1), 1-15.

OCTOBER 2021

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POSTER 2:

First, we conducted a pilot study to determine whether and for what reasons the project would appeal to our target group –the students at TUM. Here we were able to determine a high level of interest among the survey participants. In addition, we were able to determine that a majority considered the suggestions we came up with to be helpful in supporting their *CreaThesis*. Offering examples was welcomed by most of the participants. A general guideline was also seen as a good idea, while the possible contact with art students elicited rather mixed reactions. The positive feedback reinforced our assessment of the relevance of our project for the target group, and the differentiated responses helped us to further refine our project and prioritize our next steps. The main goal was to launch our website, where the *CreaTheses* would be published, as soon as possible.

We conducted more literature research to base our approach on a strong scientific foundation. Based on this research and feedback from our tutors, we developed our final research question. As a result, we discarded the idea of a control group, which now had no relevance to answering our research question. With our newly adapted approach, we continued with our work to get the project up and running. ■



CREATHESIS

WHAT IS OUR RESEARCH ALL ABOUT?

We want to answer the question if the elaboration of a *CreaThesis* increases the science communication skills of the participants. We aim at measuring science communication skills by quantitative online questionnaires consisting of a pre-participation and a post-participation phase ("Pretest-Posttest-Design") and track the attention by user metrics.

UPDATE: WHAT HAPPENED SO FAR?

Our website is now online and provides valuable information about our project and how to participate, as well as first examples of *CreaTheses* designed by members of the team and external partners. We calculated the necessary number of participants to achieve significant results as 64 ($d = 0.5$, $\beta = 0.8$, $\alpha = 0.05$). To provide additional pull factors for participation, we issued a certificate of participation and offered a prize of 20 EURO for the first 50 participants.

The marketing campaign was kicked off. This included contacting the graduate council and all chairs of TUM, creating postcards (figure 1) and posters (figure 2) that were distributed across the university, and a social media presence via our Instagram account. In this way, we were able to establish initial contact with interested students and first participants completed the pre-test.



FIGURE 1, above

FIGURE 2, right





NEXT STEPS

In the coming weeks, the main focus will be on supporting the submissions of our participants so that we can present their *CreaTheses* on our website and start analyzing our data. During this time, we will also continue our marketing campaign and recruit more participants to obtain significant results. Soon, we will also begin writing our final report.

JANUARY 2022

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POSTER 3:

After months of intense work, valuable feedback from our tutors and supervisors, and cooperation with a variety of external partners, we developed, designed, and launched our website. Here, we not only provided important information about the project and the participation but also presented our own *CreaTheses*.

To answer our research question, we implemented a "Pre-test/Post-test" design that evaluated the participants' perceived science communication skills before and after creating a *CreaThesis* based on validated tests. We also determined the number of participants we needed for a significant result and thus set this as an intermediate goal.

To reach more people and motivate them to participate, we launched a large-scale marketing campaign. We contacted all chairs at TUM, distributed postcards and posters throughout the university, and launched our Instagram account. This led to the recruitment of the first participants who completed the pre-test.

We focused on two main aspects during this time: first, recruiting participants by pushing our social media campaign at all levels, and, second, using the experience we gained in the meantime to fix emerging issues with our website and submission process. ■



CREATHESIS

SUMMARY
 Team *CreaThesis* focused on the problem that communication of scientific theses is often neglected at TUM which also results in poor science communication skills among students. Our project aimed to find new ways to strengthen these skills while making the scientific topics the students were working on more accessible. To achieve this, participants were asked to present aspects of their theses in a creative format, a *CreaThesis*, and assess their science communication skills before and after. For this purpose, we created a website, designed a pre-post-test procedure for evaluation, and recruited participants via a marketing campaign. In the end, we were able to identify an initial trend supporting our approach and to present several *CreaTheses* on our website.

RESEARCH LIFE CYCLE



RESULTS & OUTCOME
 The results of the pre-post-test survey were not sufficient to make a significant statement, but a trend can already be identified. The participants' perceived science communication skills increased after creating a *CreaThesis* (FIGURE 1). Several examples of these *CreaTheses* such as the one presented here (FIGURE 2) can be seen on our website and provide comprehensible insights into the work of various scientific fields.

IMPACT & SUSTAINABILITY
 Our results give an impulse on how to further improve the science communication of students, and their *CreaTheses* on our website are for everyone who wants to get an insight into scientific theses and certain scientific fields. Since the infrastructure has been fully provided, future submissions would only need to be uploaded and the contents of this website could generally be extended with minimal administrative duties.

PROJECT PARTNERS/STAKEHOLDERS
 TUM: Junge Akademie

ACKNOWLEDGMENTS
 In the end, we want to thank for their indispensable and continuous support: the TUM: Junge Akademie, our supervisors Prof. Mayr and Prof. Moeckel, our tutors Sebastian Kaltenbach and Maximilian Wagner, as well as Peter Finger and the entire office team.

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MAY 2022

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inspired by
 TUM: Junge Akademie 

POSTER 4:

In the final phase of the project, small adjustments were made to the website and additional participants were motivated to take part. When all necessary steps were completed, we began a final summary of our project and a final analysis of our data. Although the number of participants did not allow for significant results, we were able to identify a statistical trend that supported our hypothesis. In addition to these results, we also describe our troubleshooting process to provide guidance on potential complications for projects using similar approaches based on our experience.

We also provide an outlook on a possible future for the project. Since all the necessary resources have already been created by our team, maintenance would probably be possible with little effort. But even without continued management, the current contents of the website give insight into different scientific areas and provides a valuable resource for current and future students.

As a team, we could conclude that by participating in the *CreaThesis* project and developing and implementing it, we all not only acquired new skills, problem-solving strategies, and perspectives, but also built a long-term network of contacts from a wide variety of fields that we hope to maintain beyond the project phase. ■