Research Report **communicaTUM**

The communicaTUM project explored how tone and format shape public perceptions of genetically modified foods in the context of food security. In Germany and Ghana, participants were shown either humorous/inspirational or contemptuous/dramatic stories about genetically modified bananas, via text or video. Surveys measured emotions, attitude shifts, and political engagement. We gained promising results for social psychology and science communication, encouraging more reciprocal dialogue between communicators and the public. These findings are a first step toward broader research on reaching especially young adults with globally relevant, anxiety-inducing topics.

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Preface by the Supervisor

Prof. Dr. Richard Bamler and Dr. Bernhard Isopp

With the rise of populist political forces, evidence- and science-based political decision-making in Germany and other European democracies has come under pressure. Scientific findings are quickly dismissed as fake news if they don't fit in with one's own worldview. This makes effective science communication all the more important, and it was the reason why I chose to become a supervisor for the communicaTUM project. First, we had to decide on a topic for which the effectiveness of different communication means had to be investigated. We excluded the most obvious topic, “climate change,” because it has already been discussed to death in the public. “Food security and GMOs” seemed to be a better choice in this aspect. As a methodological means, surveys were used to show how much the participants’ opinions about GMOs have changed or were confirmed, depending on whether they read a factual or humorous text or watched a factual or humorous video. The participant cohort comprised different age and education levels as well as national, cultural, and religious backgrounds. To be honest, it wasn't much of an effort for me to supervise the team as they worked very independently. It was a pleasure to accompany this dedicated group, and I am convinced they have the potential to become enthusiastic and successful scientists. I wish them all the best.

What was your best TUMJA moment?

My best TUMJA moment was when I heard that “my” team's application for funding for a trip to KNUST in Ghana was approved. There, they could enrich their surveys with a non-European cultural dimension. The trip was also an exciting personal experience that they will remember for a long time.

The communicaTUM team approached me to co-supervise this project with Prof. Dr. Bamler due to my work on science communication. Science communication is an exciting field because it is an area where science, technology, and society directly and visibly interact. As a research topic, it is challenging for the same reason: communication and the media are typically the purview of the social sciences, but assessing the complex and diverse ways scientific knowledge is communicated also requires a good understanding of science. What excited and impressed me about the team is how they chose their topic precisely because they wanted to take on this challenge. The team comes from natural science and engineering disciplines with relatively little background in the social sciences, but they recognized how crucial it is, as scientists, to understand how science and technology shape and are shaped by society. To this end, they developed a thoughtful and impressive project that does not imagine science to be reducible to some essential content, but rather acknowledges and examines how crucial different kinds of messaging and affect are for engagement with and understanding of science.

The Journey of communicaTUM

Exploring Science Communication Across Borders

In October 2023, a group of students came together to form communicaTUM with a shared goal: to contribute to the improvement of science communication. Our study revealed that the impact of tone and format varied notably between different participant groups. While “Nominal Participants” responded more strongly to the tone of the video, the “Interested” and “Strategic Delegators” were influenced by both the tone and the format. Across all groups, a contemptuous tone tended to provoke stronger feelings of anger. Nonetheless, some participant groups showed more pronounced, negative reactions to textual information rather than audiovisual one. These insights highlight the importance of tailoring science communication not only to the message but also to the audience it aims to reach.

Our inspiration stemmed from the ongoing anxiety about climate change, particularly among younger generations. The team aimed to explore how controversial topics could be communicated effectively, encouraging critical thinking and action without imposing a specific opinion. After extensive discussions, we decided to investigate how different tones of communication influence the perception of scientific information. Our chosen controversial subject was: genetically modified organisms. Given the increasing role of social media in shaping opinions, short videos were selected as the medium of choice.

Before launching the study, the team first had to produce the videos. We chose to focus the scripts on the Cavendish banana – crop that plays a central role in the genetic engineering debate. As a striking example of the fragility of monocultures, the Cavendish illustrates both the promise and the complexity of genetic modification. Two versions of the script were developed: one delivered in a serious tone, the other with a humorous twist. A voice actor brought both to life, accompanied by matching visuals. To assess the impact of tone on perception, the team also designed a survey that gathered demographic data and measured how participants’ views on GMOs shifted after watching the videos.

The first data collection took place in June 2024 at the Zamanand Festival. Excitement ran high as the team engaged with participants for the first time. Despite heavy rain leading to fewer visitors than expected, the thrill of seeing our project come to life and gathering initial data was immense. This was followed by participation in other events, such as the Sustainability Day in Garching, where insightful discussions on genetic engineering and science communication took place. A highlight of our journey was the visit to the DLR School Lab in Oberpfaffenhofen, facilitated by our supervisor, Professor Richard Bamler. Observing how aerospace science was communicated in an engaging and comprehensible way to young students was truly inspiring – an ideal model for science communication.

By the end of 2024, close to 600 German participants had taken part in the study. The team then contemplated expanding our research. Given the strong academic ties between TUM and KNUST (Kwame Nkrumah University of Science and Technology), and the precedent set by a previous group from #class23 traveling to Ghana, we saw an opportunity to extend our study there. Agriculture plays a significantly larger role in Ghana than in Germany, and climate change effects are more immediately felt. The team was curious to see how these factors might influence science communication.

With this mission in mind, part of the project team boarded a flight to Accra in mid-March. After a seven-hour bus ride from Accra, we arrived, exhausted but eager, in Kumasi at KNUST. The KNUST campus in Kumasi is spacious, green, and almost park-like, with many trees, botanical gardens, and a lively, open atmosphere. In contrast, the TUM campus in Garching feels more technical and compact, characterized by modern buildings, labs, and a more structured layout. While KNUST offers more nature and space, TUM focuses on high-tech infrastructure and specialized research facilities.

Our initial enthusiasm was met with a setback – the professor meant to supervise us had fallen ill, and a replacement had yet to be found. Despite this disappointment, we made the best of our unexpected free time, exploring the campus botanical gardens and the city of Kumasi. Over the weekend, we embarked on a trip to Mole National Park, where we were fortunate enough to witness elephants and antilopes in the wild. However, our adventure took an unexpected turn when we returned to our room to find that monkeys had ransacked it after we had mistakenly left the terrace door unlocked – an unforgettable lesson in wildlife awareness!

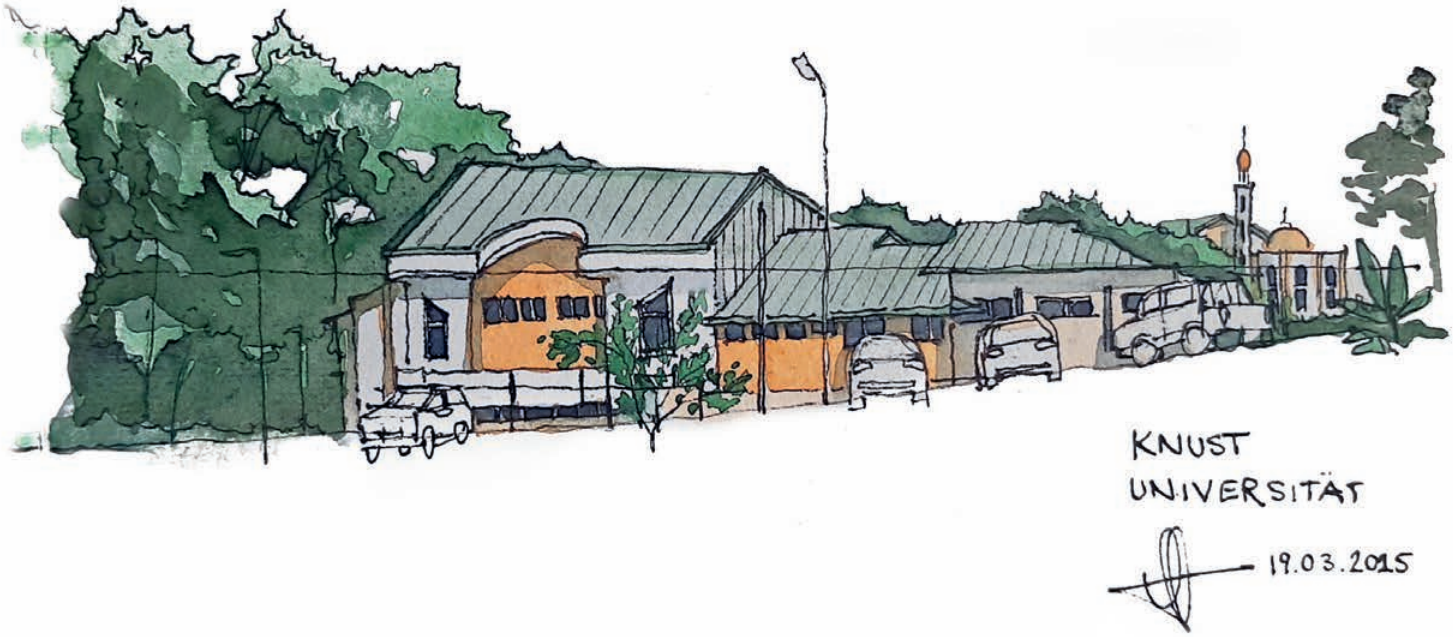
Upon returning to KNUST, we received exciting news: several professors had agreed to let us conduct our study in their lectures. We had the privilege of gathering study participants and attending lectures by Professor Philip Antwi-Agyei (Climate Change and Sustainability Science) and Professor Francis Appiah (Agricultural Science and Horticulture). The exchange with Ghanaian students proved to be invaluable. Many of them worked in the agricultural sector and had already engaged deeply with the topic of genetic engineering. They, too, were keenly interested in how such topics could be communicated effectively within their communities.

One particularly insightful conversation unfolded after a lecture by Professor Appiah. “Ghanaian farmers are often urged to use GMO seeds, which promise higher outputs. The land, however, is left with varying degrees of quality,” elucidated David, a master’s student with extensive experience in the agricultural sector. He continued, “A lot of communication between farmers and scientists will be needed to bring the dream of sustainable GMO farming to fruition.” His words reflected the complex balance between innovation and environmental responsibility in Ghana’s farming practices.

Another moment that stuck with the team was a simple yet powerful comment from a local taxi driver in Kumasi: “Ghana needs more farmers.” This statement echoed through many of the conversations our group had in the following days. It emphasized how central agriculture is to the country’s identity – and how crucial it is to include all voices in the discussion about its future, especially when it comes to controversial technologies like genetic modification.

By the end of our time in Kumasi, the team had collected data from over 120 participants. Before concluding our journey, we took the opportunity to explore Ghana further. In Kakum National Park, we marveled at the rainforest from treetop walkways and even spent a night in a treehouse. Our trip continued to Cape Coast, where we learned about Ghana’s history as a hub of the transatlantic slave trade – a sobering and educational experience. One key takeaway from our time in Ghana was the realization that science and science communication are deeply influenced by cultural contexts.

As our tenure at TUMJA ended, our team reflected on our achievements with pride. We had successfully conceptualized, designed, and conducted our own research project – one that spanned continents. Grateful for this opportunity and for all the lessons learned, we closed this chapter in our lives with a heartfelt “Thank you!” to everyone who has supported us along the way.



Research Report – communicaTUM

The impact of tonality on the acceptance of new technologies is dependent on culture, medium and sociodemographic factors

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Abstract

The communicaTUM project investigated how communication tonality and medium affect public perceptions of genetically modified foods within the context of food security. Participants in Germany and Ghana were exposed to either humorous and inspirational or contemptuous and dramatic versions of a story about genetically modified bananas, presented via text or video. Surveys assessed emotional responses, changes in attitudes toward GMOs, and willingness to take political action. Results showed that while dramatic communication elicited stronger emotions, text formats generally had a greater impact on attitude change than videos. Ghanaian participants exhibited higher engagement, greater concern about food insecurity, and more positive attitudes toward GMOs compared to their German counterparts. Cluster analyses revealed distinct engagement patterns within both populations, highlighting the significant influence of sociocultural context. This study underscores the importance of emotional tonality, communication medium, and cultural factors in shaping science communication effectiveness, particularly when addressing complex and controversial topics like genetic engineering.

Background

The inspiration for our project comes from the growing awareness that communicating scientific issues has a significant impact on public perception and mental well-being. A clear example of this is the shift in terminology from "global warming" to "climate change" since 1990 (Ellen Good, 2008). This change was necessary to give a more refined sense of the climate crisis, while reducing the sense of alarm associated with the term, aiming for a more neutral and comprehensive way to describe the phenomenon. However, even with these adjustments in language, the emotional and psychological effects of climate-related discussions remain substantial, particularly among younger generations (Majeed & Lee, 2017).

Research has shown that many young people experience "climate anxiety," a growing sense of distress, depression, and hopelessness about the future of the planet. A large-scale study surveying over 10,000 young individuals found that the majority feel worried about climate change, with many also frustrated by what they see

as insufficient action from governments (Hickman et al., 2021). This highlights the importance of carefully considering how we communicate complex scientific topics – not just to inform, but also to ensure that messaging does not contribute to fear and anxiety. Our project builds on these insights, exploring how communication strategies shape attitudes toward genetic modifications in food and food security.

Similar to the discourse surrounding climate change terminology, the term "genetic modifications" often evokes perceptions of risk and unnaturalness among the public. This negative connotation has led to resistance to the promotion of genetically modified organisms (GMOs), with concerns spanning health risks, environmental impact, and ethical considerations. For instance, a study on public attitudes in Wales highlighted that "the transfer of genes between different species is often criticized as “playing God” or breaking the “Law of Nature” (Mulready, 2017). Furthermore, research indicates that the terminology used significantly influences public acceptance; for example, terms like "bioengineering" are perceived more neutrally compared to "genetic modification," which carries more negative associations (Marcus & Velardi, 2023). These insights underscore the importance of mindful communication strategies in the field of genetic engineering to foster informed public discourse and acceptance.

Understanding and clarifying the impact of genetic modifications on food and public perception is crucial in today's global landscape. While Europe maintains a cautious stance on genetically modified (GM) foods, countries like the United States and China have embraced their integration into common food products. This divergence underscores the need for comprehensive public education and transparent communication regarding the benefits and risks associated with GM foods. Effective communication strategies can bridge the gap between scientific advancements and public understanding, fostering informed decision-making and acceptance.

The significance of directed genetic modifications cannot be overstated, as they represent one of the most pivotal technologies of the 21st century. Advancements such as CRISPR-Cas have revolutionized genetic research, offering precise and efficient tools for crop improvement and disease resistance (Redman et al., 2016). These technologies, while also bringing severe ethical considerations into account (Shinwari et al., 2018), hold the potential to address global challenges, including food security and environmental sustainability. As genetic modification techniques continue to evolve, their integration into various sectors is likely to expand, making it imperative to engage the public in meaningful dialogues about their applications and implications. Therefore, this study aims to examine how different communication tonalities (humorous & inspirational vs. contemptuous & dramatic) influence the way the general public processes news about genetically modified foods. By exploring the impact of tonality on audience perception, this research aims to contribute to the development of strategies for more effective science communication.

Genetic modifications refer to the deliberate alteration of an organism’s genetic material using biotechnology to achieve specific traits. This process can involve the insertion, deletion, or modification of genes to enhance characteristics such as pest resistance, drought tolerance, or nutritional value in crops. Techniques such as transgenesis, where genes from one species are introduced into another, and gene editing, which allows precise modifications without introducing foreign DNA, have significantly advanced agricultural biotechnology (Zhang et al., 2021). These innovations play a key role in modern food production, aiming to improve yield, reduce reliance on chemical pesticides, and contribute to global food security. Thus, genetic modifications have enabled targeted improvements that would be difficult to achieve through conventional breeding.

CRISPR-Cas9 is a groundbreaking gene-editing technology that allows scientists to make precise changes to DNA, the molecule that carries genetic information in living organisms. Originally discovered as a natural defense mechanism in bacteria, where it protects against viral infections, CRISPR-Cas9 has been adapted for use in various organisms, including humans, plants, and animals (Jinek et al., 2012). The system works by using a custom-designed

guide RNA (gRNA) that matches a specific DNA sequence targeted for editing. Once inside the cell, the gRNA directs the Cas9 enzyme to this exact location, where Cas9 acts as molecular scissors, cutting the DNA strand. The cell's natural repair mechanisms then attempt to fix the break, providing an opportunity for scientists to introduce specific genetic modifications, such as inserting or deleting DNA segments.

This technology has revolutionized genetic research and biotechnology due to its simplicity, efficiency, and versatility. It enables targeted modifications with unprecedented precision, facilitating advancements in medicine, agriculture, and basic science. CRISPR-Cas9 holds the potential to correct genetic mutations responsible for diseases, enhance crop resilience, and to study gene functions comprehensively. The development of this method is credited to Emmanuelle Charpentier and Jennifer Doudna, who were awarded the 2020 Nobel Prize in Chemistry for their pioneering work. Their research transformed CRISPR-Cas9 from a bacterial immune system into a versatile genome-editing tool, opening new frontiers in genetic engineering while also raising important ethical considerations (Ledford & Callaway, 2020).

Genetic modifications have led to significant advancements in both medicine and agriculture. In medicine, this has enabled the development of precise editing of defective genes responsible for various diseases, offering potential cures for genetic diseases such as sickle cell anaemia and certain cancers (Xu et al., 2024). In agriculture, genetic modifications have resulted in crops with enhanced properties, such as disease-resistances or higher nutritional profiles. A notable example is Golden Rice, engineered to produce beta-carotene, a precursor of vitamin A. This rice, developed by Ingo Potrykus and Peter Beyer, aims to address vitamin A deficiencies prevalent in some developing countries (Beyer et al., 2002).

Prior to the advent of modern genetic modification techniques, traditional breeding methods such as selective breeding and hybridization were employed to enhance desirable traits in plants and animals. In plant breeding, techniques like irradiation mutagenesis were utilized to induce genetic variability. This approach involved exposing seeds or plant tissues to ionizing radiation, such as gamma rays, to create mutations that could result in beneficial traits. However, this method often led to unintended genetic changes, raising concerns about potential health and environmental risks associated with the consumption and cultivation of such crops (Ma et al., 2021).

In animal husbandry, inbreeding—mating closely related individuals—was commonly practiced to reinforce specific traits within a population. While this approach could establish desirable characteristics, it also increased the likelihood of expressing deleterious recessive genes, leading to inbreeding depression. This phenomenon manifests as reduced fertility, lower growth rates, and increased susceptibility to diseases in livestock populations. Studies have documented the negative impacts of inbreeding on dairy cattle, highlighting declines in reproductive performance and overall fitness (Gutiérrez-Reinoso et al., 2022).

The challenges posed by traditional breeding methods, such as unintended mutations from irradiation in plants and genetic weaknesses from inbreeding in livestock highlight the need for more precise and sustainable approaches in agriculture. While these older techniques have shaped modern food production, they often come with significant risks and limitations. In contrast, genetic modification provides a targeted and efficient alternative, allowing for controlled improvements without the unpredictability of conventional methods. This innovation is particularly crucial in addressing current agricultural threats that could jeopardize global food security.

A striking example of this necessity is the crisis facing the Cavendish banana, the dominant variety in global markets, which is now under threat from *Fusarium oxysporum* f. sp. *Cubense* TR4 (Butler, 2013). This situation mirrors the mid-20th-century devastation of the Gros Michel banana, which was nearly wiped out by a similar fungal strain. Due to its genetic uniformity, the Cavendish is highly susceptible to TR4, making it vulnerable to the same fate. However, genetic modification offers a promising solution. A study published in *Nature Communications* demonstrated that introducing a resistance gene from a wild banana species into Cavendish bananas successfully conferred TR4 resistance without compromising yield or quality (Dale et al., 2017). This breakthrough exemplifies how genetic engineering can provide practical solutions to urgent agricultural challenges, reinforcing the importance of effective science communication in fostering public understanding and acceptance of such technologies and food security.

Goals and Methods

This project was based on the promising results of genetic engineering in Cavendish bananas to avoid TR4 infection, and aimed to bring this story to the German and Ghanaian public, while exploring the attitudes of the different people towards genetic modifications in the food security context. Two contrasting tonalities – humorous & inspirational vs. contemptuous & dramatic – were used to convey the situation, while two different message media (text vs. video) were also used.

In order to reach the public, wide-ranging surveys were developed. Every experiment started with a pre-survey requesting general background information – age, sexual identity, education level, religious alignment. Furthermore, questions regarding participants' attitudes towards the current food security situation and genetically modified food were added. Finally, the pre-survey also contained general questions regarding their engagement with science and technology based on Okamura, 2016.

This was followed by exposure to the story, either by video or text. The tonality of this story was randomly assigned to each participant. After exposure, each participant received the post-intervention survey, containing questions regarding their fears, emotional response and opinions towards the story.

The answers to most questions were coded with LIKERT scales from 1-5 (Phillips et al., 2002), except the questions from Okamura, 2016, which went from 1-4. Furthermore, free-form questions were included in order to let the participants express their unfiltered opinions towards the story report, while also testing their information retention.

The surveys were distributed in fairs such as the Zammanand, the TUM Sustainability Day and the TUM Open Days. Furthermore the survey was introduced into the school context via the DLR School Labs. In parallel, university students were surveyed via the lectures of Prof. Werner (Computational Foundations) and Dr. Schröpfer (Sociology). The surveys aimed towards the German population were formulated in German, while the ones for the Ghanaian population were translated into English. Analogously, videos and texts were adapted to the targeted population. All data was collected through evasys. In Ghana, students were surveyed in lectures from Prof. Francis Appiah and Prof. Antwi-Agyei, and also online via the IPO website: **Enhancing Scientific Communication: Participate in Research with communicaTUM at KNUST! | International Programmes Office**

Once all data was collected, statistical analysis followed. The first step of the statistical analysis was based on clearing the dataset of any unresponsive participants, hence allowing for a better statistical analysis in RStudio. A k-cluster analysis based on Bobbitt, 2020, was performed, aiming to discover the population clusters with regards to their general attitudes towards science and technology (Okamura, 2016). Prior to that, it was necessary to perform an optimization test, aiming to discover the correct number of clusters to be assigned to our dataset. In order to realize this, two diagrams were represented (cf. Figure 1) – Number of Clusters vs. Total Within Sum of Squares & Number of Clusters vs. Gap Statistic (Tibshirani et al., 2001). With the resulting optimal number of clusters (k = 5), the k-cluster analysis was performed and each participant was categorized into one of the 5 clusters: Nominal Participants, Passerby, Interested, Onlooker and Strategic Delegators (cf. Table 1).

The code to the k-cluster analysis can be found here: https://github.com/VicenteAlgaba/communicaTUM-k-cluster-analysis.git

Building upon the k-cluster analysis, a series of correlation analyses were conducted to examine the relationships between participants' age, religious affiliation, and political stance with their trust in GMOs, concerns about food insecurity, and emotional responses (anger/fear) toward GMOs. As a preprocessing step, participants with incomplete questionnaire responses were excluded from the dataset to ensure data integrity. All analyses were performed using MATLAB.

Finally, the key part of the statistical analysis consisted of the analysis of variance (ANOVA) for the four interventions: contemptuous, humorous and for each as a text or video. Due to a sample size exceeding $n > 30$, normal distribution was assumed to apply (Corcoran, 2016). The ANOVA focused on the questions contained in the post-intervention survey. When the results reached significance, a subsequent Tukey-Test was performed indicating which interventions resulted in substantial differences in their answers and attitudes. Boxplots were produced, visualizing the differences between each of the group`s results. Furthermore, the different

cluster groups were analyzed with ANOVA based on their responses to the questions above. All analysis and data visualization was produced in MATLAB.

Results and Discussion

Cluster analysis – Germany, Munich

Prior to conducting the rigorous statistical analysis of the various conditions in our surveys, and the impact of medium and tonality on information processing, it was necessary to mathematically determine the optimal number of clusters within the sample.

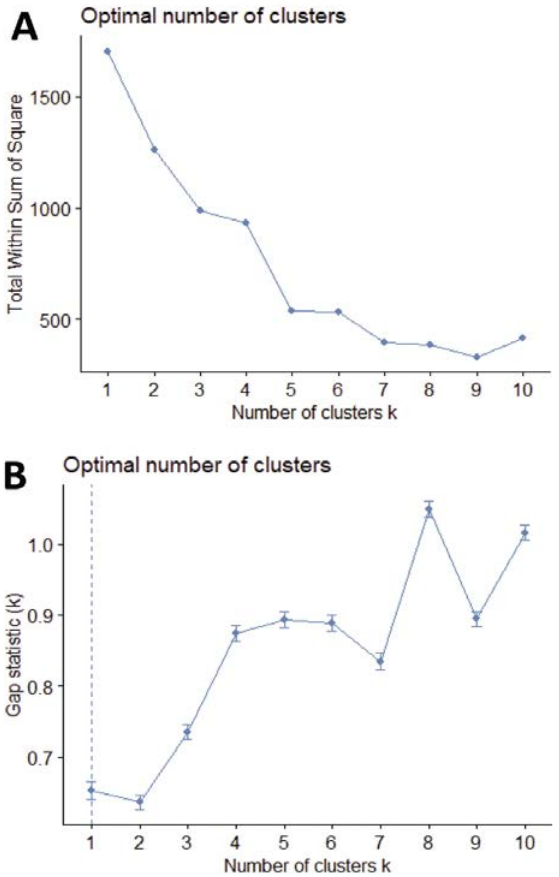


Figure 1: Optimization of cluster number via Total Within Sum of Square (A) and Gap Statistic (B) in German student population from the Technical University of Munich.

Based on the Total Within Sum of Square (A), the aim is to search for a so-called "elbow," where the sum of squares begins to level off. The lowest elbow in this diagram corresponds to k = 9. Nonetheless, given the context of a small scientific population, the local elbow in k = 5 suffices. Alternatively, based on the Gap statistic, the most optimal cluster would be the one with the highest gap statistic. Here, k = 8 seems to have the highest value. Nonetheless, we can again find a very plausible local maximum at k = 5. This was chosen to be the most optimal cluster number.

Based on this, the k-cluster analysis could start. For this, every participant was assigned to a cluster, and based on their values on science and technology engagement (cf. Supplementary Table 1 in Appendix), these clusters were named as follows:

Index	Cluster Name	Description
1	Nominal Participants	Suggests they participate to fulfill minimal requirements or expectations.
2	Passerby	Minimal engagement, emphasizing transience or incidental presence.
3	Interested	Very high interest and participation & very low delegation
4	Onlooker	Suggests someone watching with curiosity or interest, possibly with a hint of detachment.
5	Strategic Delegators	Implies a deliberate and organized approach to involvement and delegation.

Table 1: Assignment of Cluster Name based on Cluster Values based on German student population.

It must be noted that our study largely focuses on educated people surrounding the university context. This can be easily seen by the fact that parameters such as "interest" and "delegation" do not vary very strongly between the different clusters (cf. Supplementary Table 1). If compared with other large-population studies such as Okamura 2016 (Japan), it is clear that the clusters in this study tend towards having a higher "interest" in the topic. This could be explained by the fact that most of our surveys were performed in the university context, but also due to cultural differences between the Japan population towards the German population. Any conclusions taken from this study are thus specifically tailored to the educated population, and should be viewed with caution in relation to its effects on different populations as a whole.

Cluster analysis – Ghana, Kumasi

As for the collected German sample, a cluster analysis was performed on the measured data from Ghanaian students at the KNUST (n = 126).

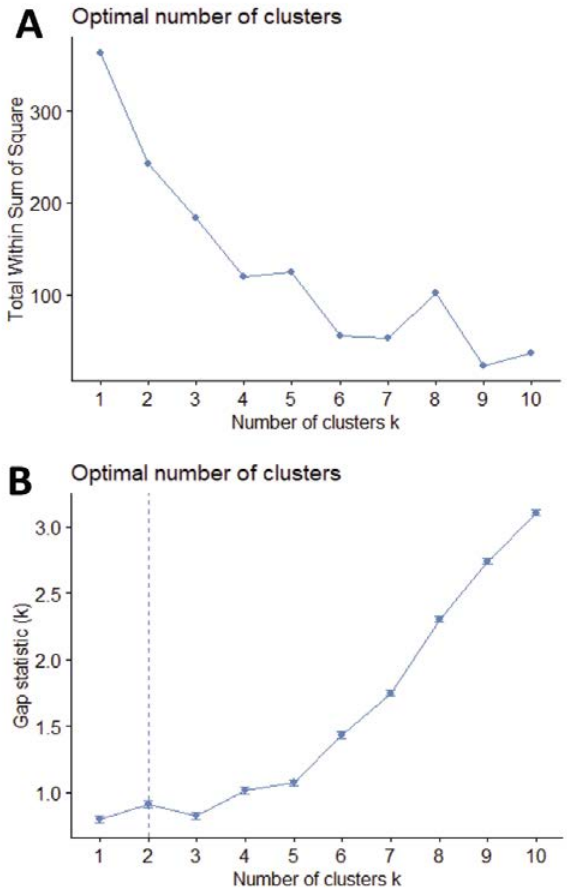


Figure 2: Optimization of cluster number via Total Within Sum of Square (A) and Gap Statistic (B) in Ghanaian student population from the Kwame Nkrumah University of Science and Technology.

Based on the same criteria as for the German population, it seemed that the most plausible cluster amount in the Ghanaian student population was k = 4. Nonetheless, with a significantly lower sample size of n = 126, the k-cluster analysis cannot be performed with the same certainty as in the German student population. As for the characteristics of the clusters itself, it was possible to find overlapping clusters between the German and Ghanaian student populations. The cluster groups "Interested" and "Strategic Delegators" could be easily found in our surveyed sample. Even so, two new different cluster groups could be found, defined as follows.

Index	Cluster Name	Description
1	Strategic Delegators	Implies a deliberate and organized approach to involvement and delegation.
2	Residual	Group that does not engage with the topic at all. Lowest interest of all, no participation and no delegation.
3	Highly invested & delegation-aware	A cluster showing mixed values between "Interested" and "Strategic delegators," People on this cluster are highly interested in the topic, participate actively in it yet are very open to delegating important decisions.
4	Interested	Very high interest and participation & very low delegation

Table 2: Assignment of Cluster Name based on Cluster Values from Ghanaian student population

It must also be noted that, while the collected sample size at the KNUST was lower, the student population there seemed to be actively more interested and engaged with the topic. While in TUM students the lowest interest mean was calculated to be 1,8 in the "Passerby" cluster, in Ghanaian students this parameter reached a minimal value of 2,5 in the "Residual" cluster, suggesting that students at the KNUST could find the topic more appealing and relevant than the German population. Given that the "Residual" cluster is only composed of 2 members, it can be said that the vast majority of our sample found food insecurity and genetic modifications a highly relevant, pressing, and thought-worthy topic.

Analysis of the post-intervention questions – Germany, Munich

This section presents the findings from the data analysis, organized into five subsections corresponding to the questions posed in the post-survey. It is important to note that the survey was conducted in German, and the questions presented here are translations of the original versions. The results are visualized using box plots, which compare the different formats (video vs. text) and tonalities

(contemptuous vs. humorous). Asterisks in the plots denote statistically significant comparisons (p-value = 0,05).

The analysis indicates that the videos had a comparatively weaker impact on participants' attitudes toward genetic modification than the texts. Notably, the "Nominal Participants" cluster displayed a more pronounced response divergence than the other clusters. Participants in this group were markedly more influenced by the text than by the videos, with their responses revealing the largest differences between the two formats. This suggests that textual content resonated more strongly with this particular cluster, potentially due to their pre-existing engagement, cognitive preferences, cultural influences or university training.

The rest of the clusters, the "Passerby," the "Interested, the "Onlooker," and the "Strategic Delegator" clusters, showed a similar

Question/Statement 1
Has the video/text changed your attitude towards genetic modification?
If so, how has your attitude towards genetic modification changed?

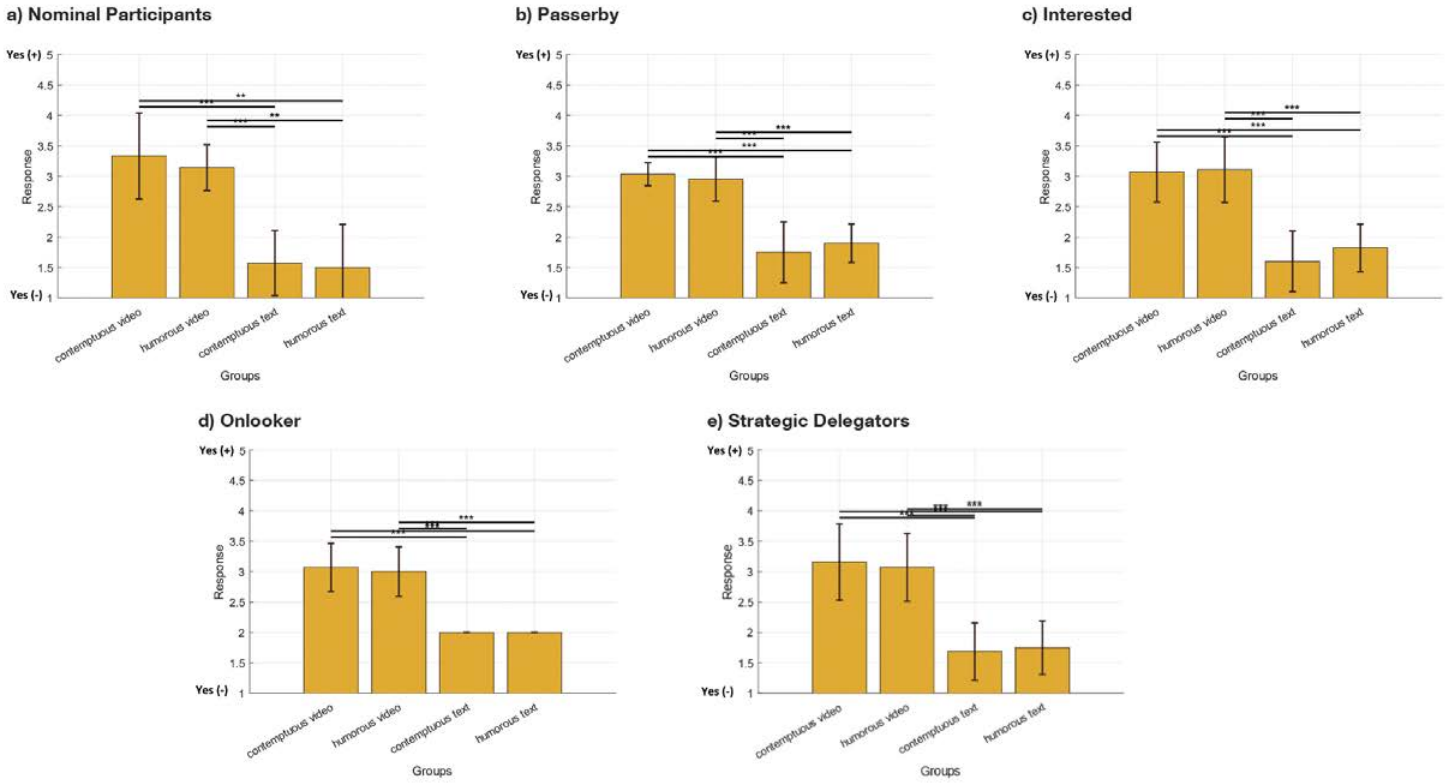


Figure 3: Response of the different German clusters to the question "Has the video/text changed your opinion towards genetic modification? If so, how has your attitude towards genetic modification changed?," Their responses were evaluated with a LIKERT scale from 1-5, with 1 being a negative change of attitude, 3 no change in attitude and 5 a positive change of attitude towards genetic modification. The clusters are a) Nominal Participants, b) Passerby, c) Interested, d) Onlooker, e) Strategic Delegators. All clusters were evaluated via ANOVA.

behavior. The box diagram for these groups, however, is characterized by a relatively flat distribution across the medium and the tonalities, indicating less variation in responses in these clusters and participants experiencing less of a shift in perspective.

Taken together, these findings underscore the varying degrees to which participants were influenced by the different formats. While textual content consistently elicited stronger negative attitudinal changes, the impact of videos was more subdued and contingent on the cluster's characteristics. Videos seemed to generate a softer response.

The data from the "Onlookers" and "Passerbys" clusters did not provide meaningful insights. The responses from these groups fluctuated around a value of 2, with no discernible trend. Additionally, the large standard deviation (on the order of 1.5 units) further

Question/Statement 2
The video/text made me angry.

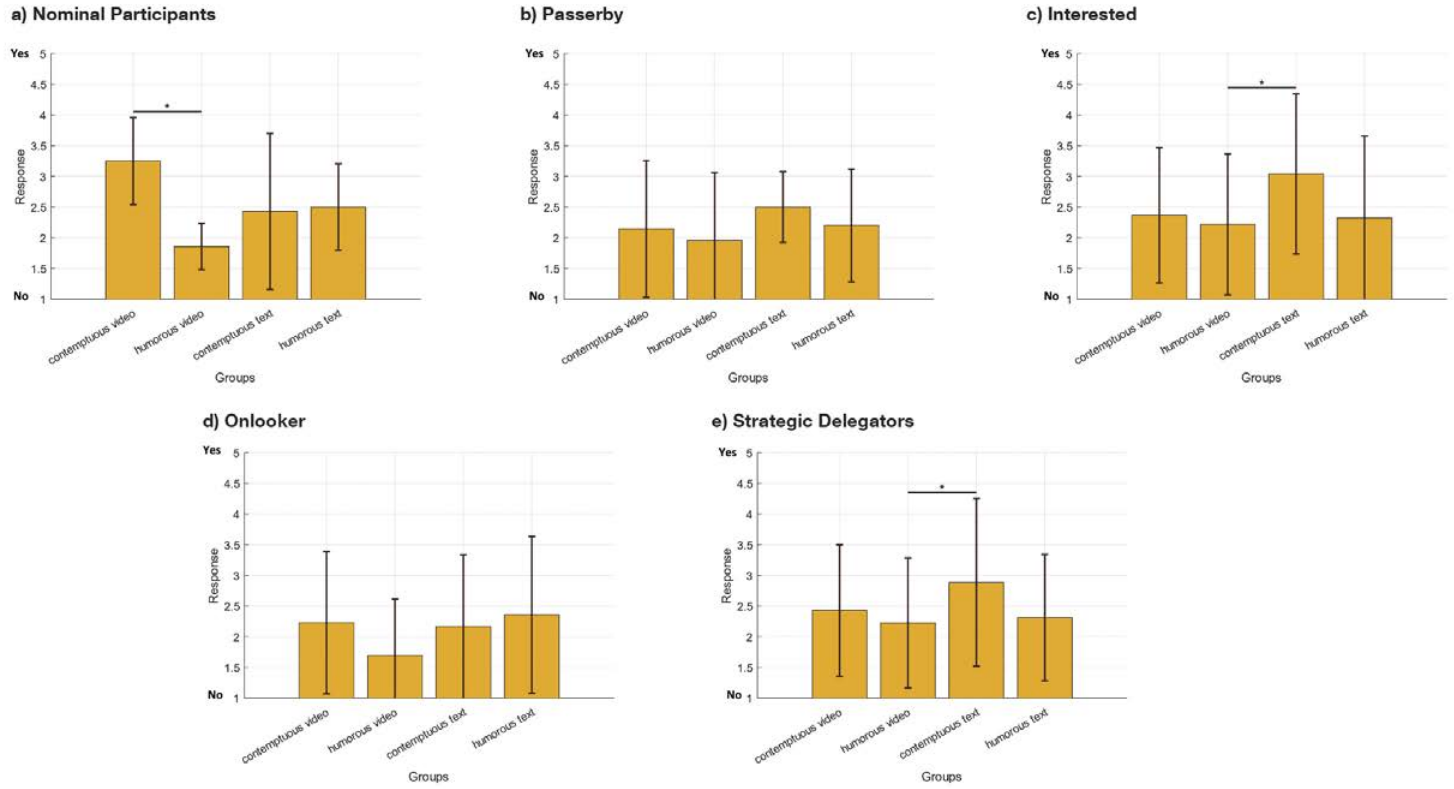
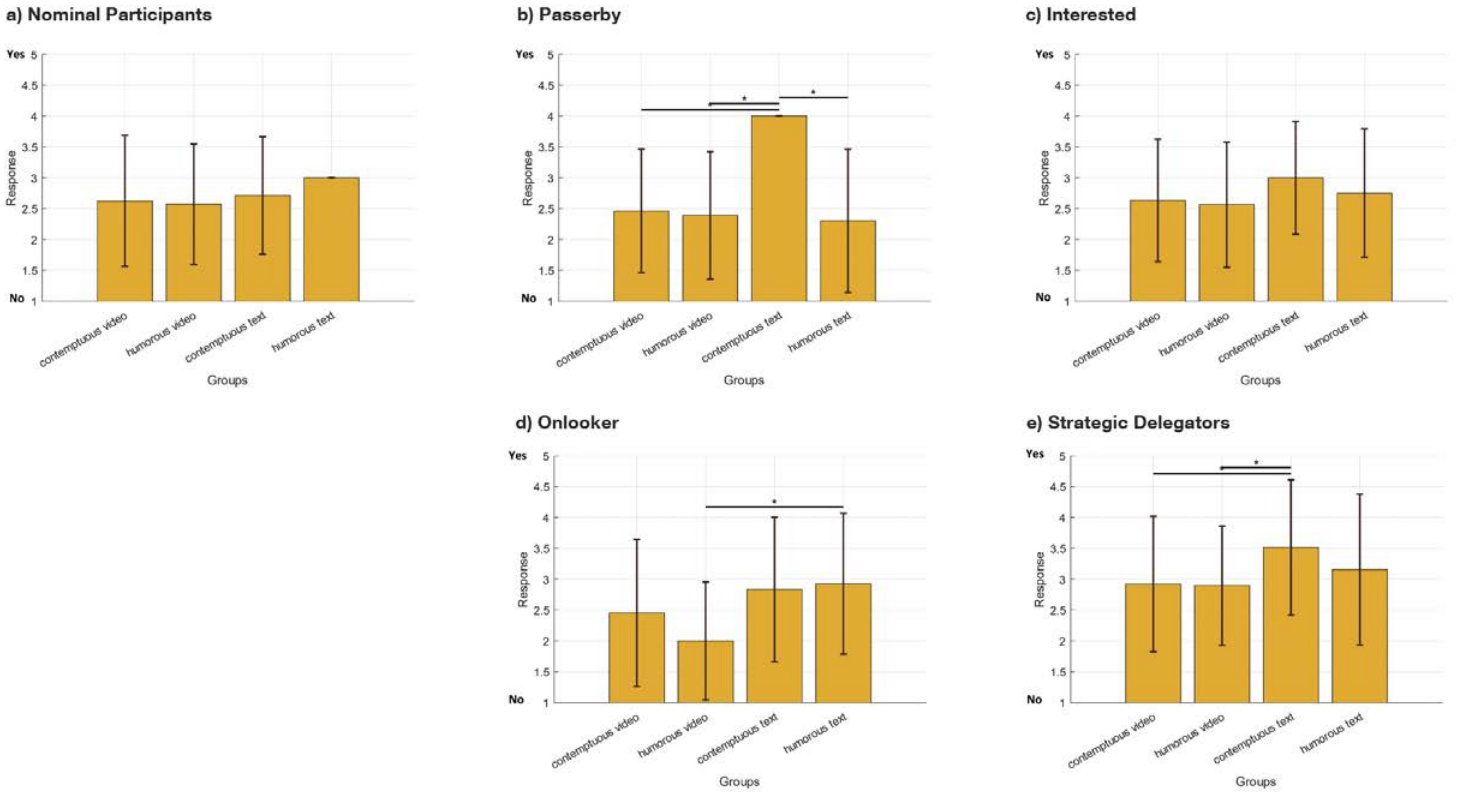


Figure 4: Response of the different German clusters to the statement "The video/text made me angry," Their responses were evaluated with a LIKERT scale from 1-5, with 1 being "No" and 5 being "Yes," The clusters are a) Nominal Participants, b) Passerby, c) Interested, d) Onlooker, e) Strategic Delegators. All clusters were evaluated via ANOVA.

limits the ability to draw reliable conclusions about these clusters. This high variability suggests that participants in these groups reacted inconsistently to the stimuli, making it difficult to identify clear patterns or effects. In contrast, the “Nominal Participants” cluster produced more insightful results. As illustrated in Fig. 4 (a), the contemptuous video elicited significantly stronger feelings of anger among these participants compared to the humorous video. It is also worth noting that the contemptuous text elicited highly varied reactions, as indicated by its large standard deviation.

Finally, the “Interested” and “Strategic Delegators” clusters exhibited similar response patterns, which differed markedly from those of the “Nominal Participants.,” Both clusters reported significantly stronger feelings of anger in response to the contemptuous text compared to the humorous video, with a difference of more than one unit on the response scale. While the “Nominal Participants” were more sensitive to the tonality of the video, the “Interested” and “Strategic Delegators” were more strongly influenced by both the tone and the difference in the medium.

Question/Statement 3
I feel that I need to take a political stance against the issue of food insecurity.

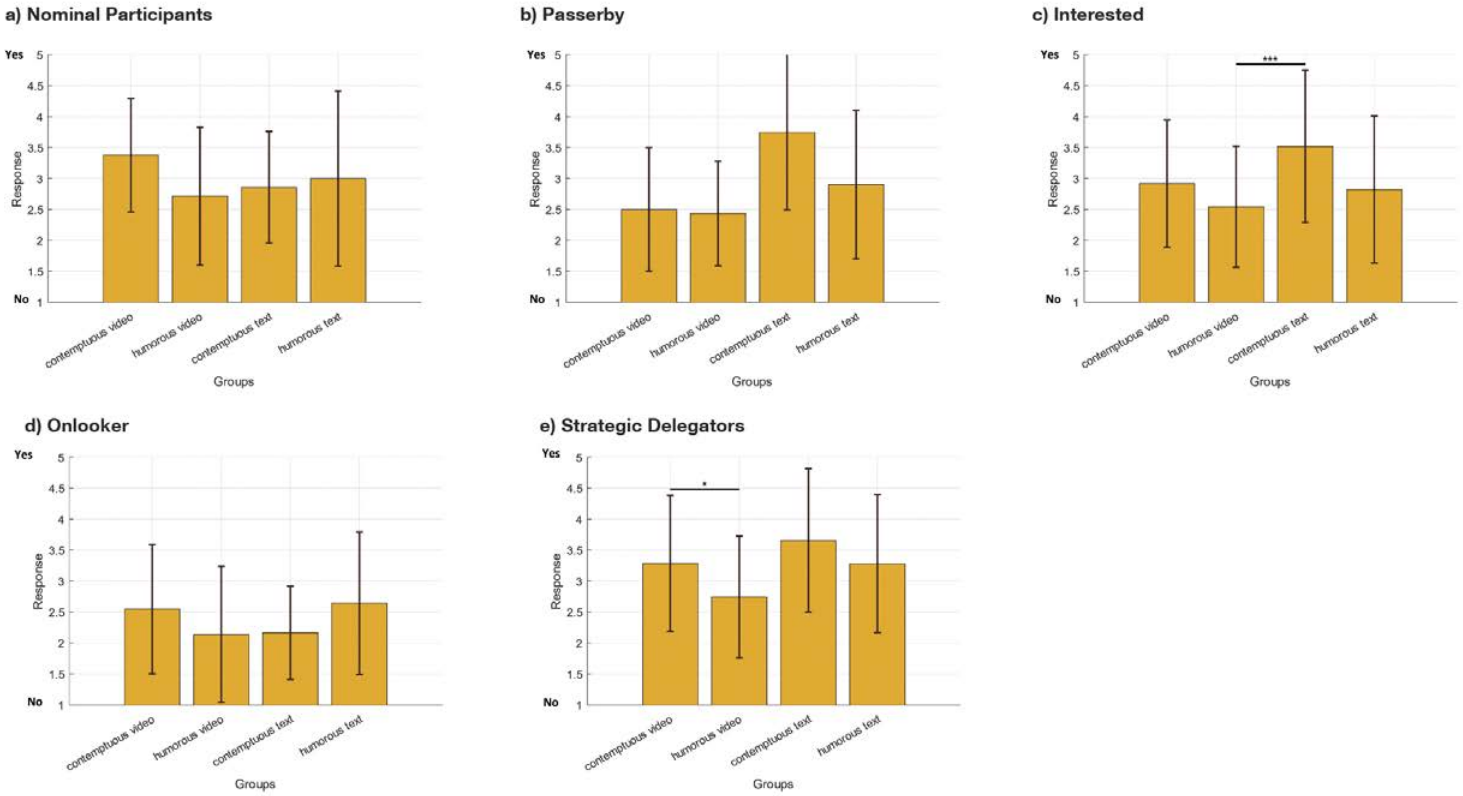


This statement elicited very similar reactions from both the "Interested" and "Nominal Participants" clusters. However, the responses from the "Passerby" cluster provided more meaningful insights into the effects of medium and tonality. The contemptuous text emerged as the most influential stimulus, evoking a stronger sense of urgency to take a political stance against food insecurity compared to all other formats and tonalities. The mean response for the "Passerby" to the contemptuous text was 4 out of 5, significantly higher than the responses to other stimuli, none of which exceeded 2.5 units. This stark contrast highlights the unique effectiveness of the contemptuous text in mobilizing this particular cluster.

The "Onlookers" cluster exhibited a more intense reaction to the humorous text than to the humorous video, with mean response values of approximately 3 and 2, respectively. However, no other statistically significant comparisons could be made for this cluster, limiting further conclusions about their responses.

Finally, the "Strategic Delegators" cluster displayed a response distribution that resembled a flattened version of the "Passerby" distribution. Similar to the "Passerby," the contemptuous text evoked the strongest feelings among the "Strategic Delegators," However, this effect was only statistically significant when com-

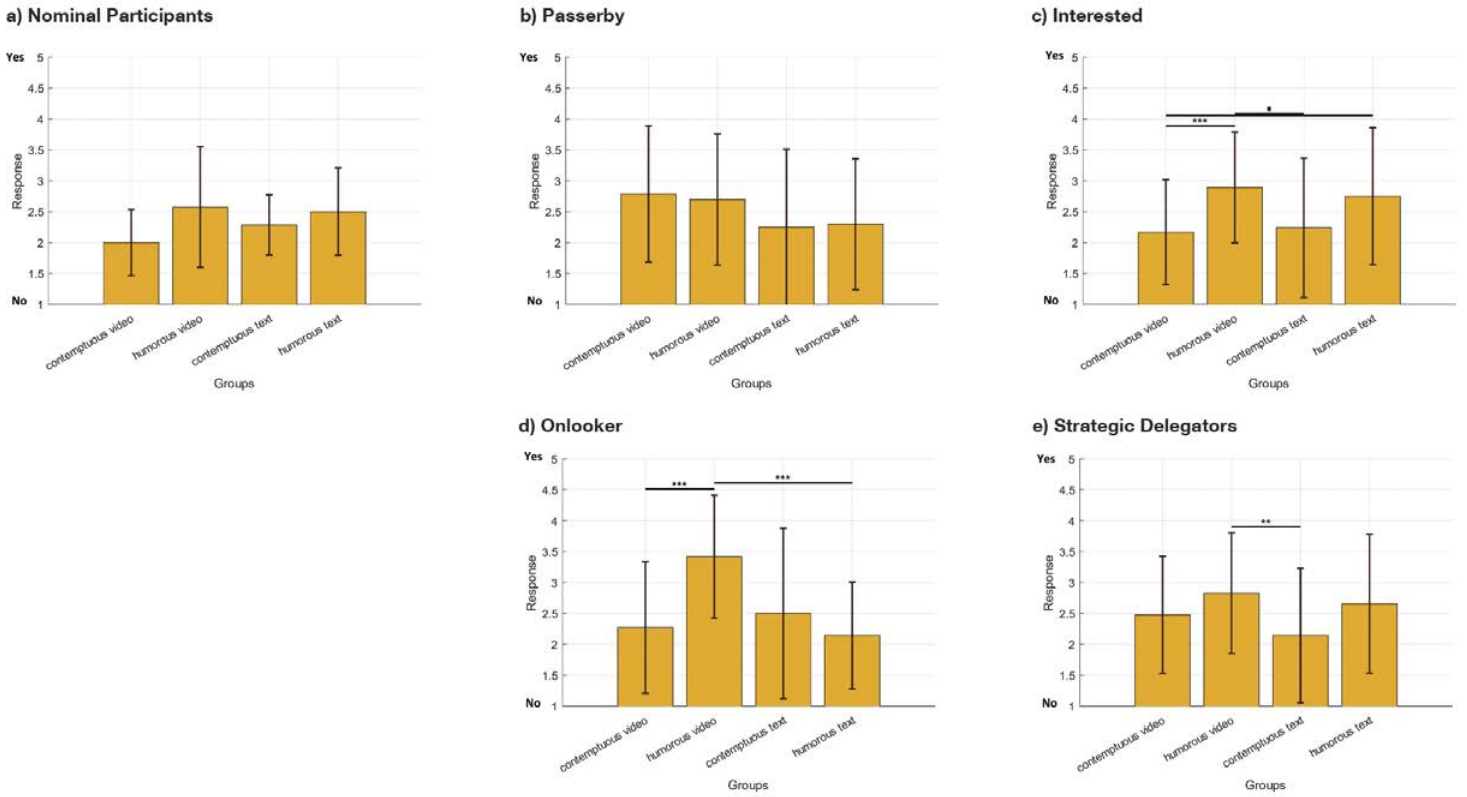
Question/Statement 4
The video/text raised concerns for me.



pared to the video formats, not when compared to the humorous text. This suggests that while the contemptuous text was impactful, its influence was not uniformly dominant across all comparisons within this cluster.

The clusters “Nominal Participants” and “Onlooker” did not provide significant insights in the context of the statement about raised concerns. Analogously to Statement 3, the “Passerby” cluster seemed to show an increased amount of concern after reading the contemptuous text, which also correlates to the increased feeling of having to engage politically with the topic (cf. Fig. 5, b). For the “Interested” cluster, the key finding is that the contemptuous text was also more effective in raising concerns compared to other formats and tonalities. None of the other comparisons within this cluster reached statistical significance, underscoring the unique impact of the contemptuous text on this group. But, even though this cluster`s concerns were raised by the contemptuous text, their response in having to take a political stance did not increase in comparison to the “Passerby” group (cf. Fig. 5b, c), probably because the “Interested” group already partakes in political activities on this matter.

Question/Statement 5
The video/text left me with the impression that the situation is under control.



The “Strategic Delegators” cluster exhibited a distinct pattern: participants in this group were more concerned by both the contemptuous text and the contemptuous video than by the humorous video. Interestingly, the statistical significance and the magnitude of the difference were stronger between the contemptuous text and the humorous video than between the contemptuous video and the humorous video. However, no conclusions can be drawn regarding the comparison between the contemptuous and humorous texts, as this difference did not reach statistical significance.

While the contemptuous text consistently emerged as a powerful stimulus, its impact was most pronounced among the “Interested” and “Strategic Delegators” clusters. The lack of significant results for the “Nominal Participants”, “Passerby”, and “Onlooker” clusters suggests that these groups were less responsive to the stimuli in the context of raised concerns.

The responses from the “Nominal Participants” and “Passerby” clusters did not provide meaningful insights into whether participants felt the situation was under control. The data from these groups lacked clear trends or statistical significance, making it difficult to draw any conclusions about their perceptions.

In contrast, the “Interested” cluster exhibited a more insightful distribution in response to this statement. The humorous video left participants with a significantly stronger impression that the situation was under control compared to both the contemptuous video and the contemptuous text. Additionally, an interesting comparison can be made between the humorous text and the contemptuous video: the latter left participants feeling less confident that the situation was under control. However, no other comparisons reached statistical significance, limiting further conclusions for this cluster.

The “Onlookers” cluster also demonstrated notable patterns. Participants in this group felt significantly more confident that the situation was under control after viewing the humorous video compared to the contemptuous video and the humorous text.

The humorous video consistently emerged as the most effective in fostering a sense of control, particularly among the “Interested” and “Onlookers” clusters. However, the lack of significant results for the “Nominal Participants”, “Strategic Delegators” and “Passerby” underscores the challenges of engaging these groups on this issue.

Quantitative comparison Kumasi/Munich

The research team also had the opportunity to conduct the survey in Kumasi, Ghana. In the following analysis, we compare the responses of participants from Bavaria and Ghana. To ensure consistency in the comparison, only the video-based component of the survey was considered for the Bavarian sample, as the Ghanaian participants were likewise exposed solely to the video and not the text-based medium.

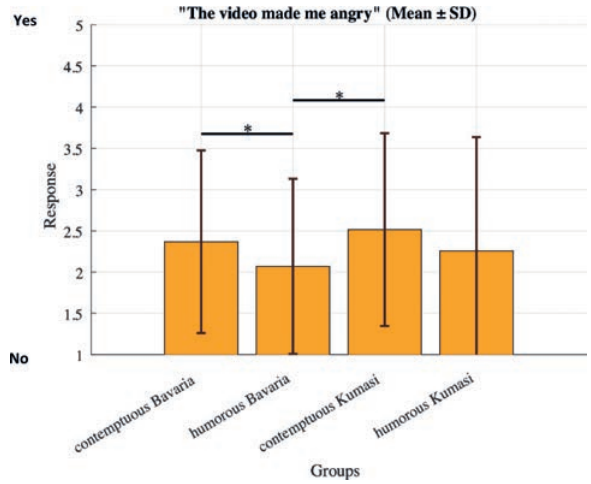


Figure 8: Mean response of the German and Ghanaian populations to the statement “The video made me angry,”

In response to the question of whether the video elicited anger, both populations exhibited similar overall trends. However, the contemptuous video appeared to provoke stronger feelings of anger among the Ghanaian participants compared to the humorous video among their Bavarian counterparts.

The responses to the question “Has the video changed your attitude towards genetic modification?” reveal more pronounced differences between the groups compared to the previous item. The contemptuous video had a significantly stronger impact on the attitudes of the Ghanaian participants than on those of the Bavarian participants, regardless of which video the latter viewed. Notably, the humorous video also elicited a marked shift in attitudes among participants in Kumasi, with their mean response reaching 4 out of 5 points – higher than any other group in the study.

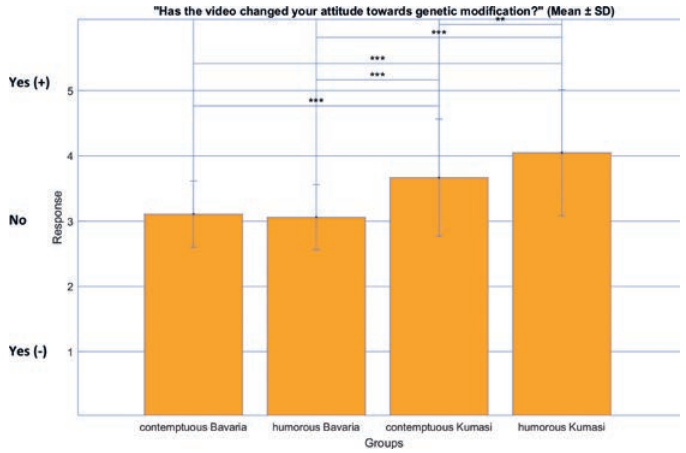


Figure 9: Response of the Ghanaian and German population to the question "Has the video changed your attitude towards genetic modification?,"

When asked whether the video raised concerns for them, participants in Kumasi reported significantly higher levels of concern on a five-point Likert scale. Both the humorous and the contemptuous videos elicited comparable levels of concern among the Ghanaian participants. In contrast, the German participants, on average, reported lower levels of concern across both video conditions.

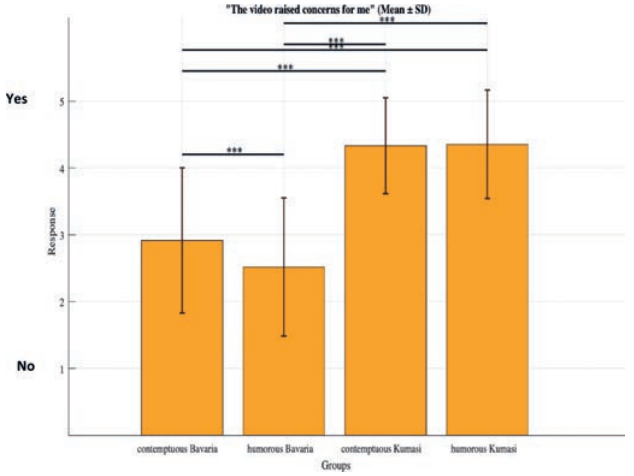


Figure 10: Response of the Ghanaian and German population to the statement "The video raised concerns for me,"

Regarding the question of whether the video left participants with the impression that the situation is under control, a discernible trend emerges in the data. German participants tended to be more pessimistic in both video conditions, with mean responses falling below the neutral midpoint of 3. This effect was more pronounced following the contemptuous video, which conveyed a weaker sense of control. In contrast, Ghanaian participants were generally more optimistic, particularly in response to the humorous video, which conveyed a stronger impression that the situation is manageable. In this case, both the comparisons between video types and between countries yielded statistically significant differences.

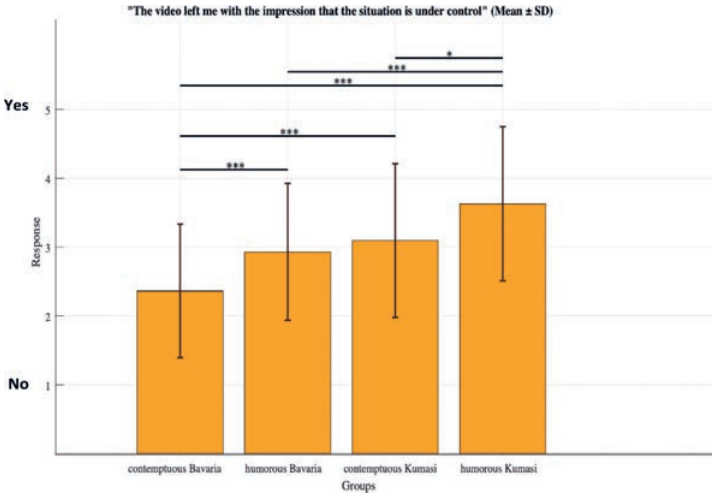


Figure 11: Mean response of the Ghanaian and German population to the statement "The video left me with the impression that the situation is under control,"

Finally, in response to the question of whether they felt the need to take a political stance against the issue of food insecurity, participants in Kumasi responded more affirmatively than their Bavarian counterparts. The Bavarian participants showed similar response levels across both video conditions, with mean values slightly above 2.5 on the five-point scale. In contrast, the Ghanaian participants reported a significantly stronger inclination to take political action, particularly after viewing the humorous video, which yielded a mean response slightly above 4. The contemptuous video also prompted elevated responses in Kumasi, though to a lesser extent, with a mean around 3.5.

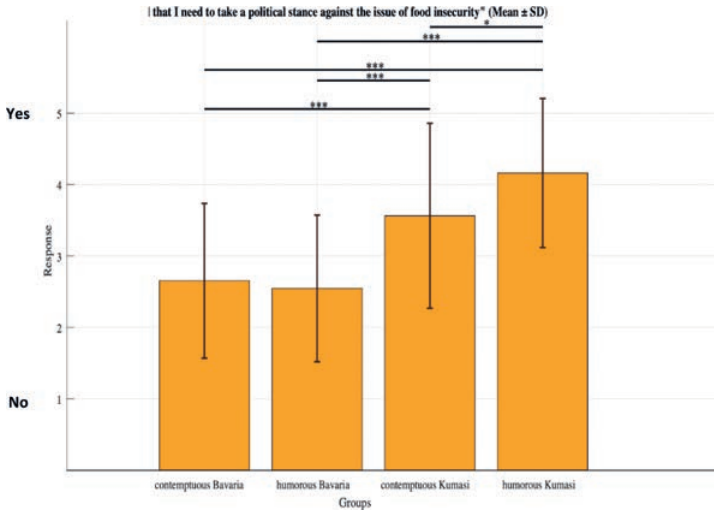


Figure 12: Mean response of the Ghanaian and German population to the statement "I feel that I need to take a political stance against the issue of food insecurity,"

Qualitative analysis – Comparison Munich/Kumasi

While most questions were designed to be analyzed quantitatively, the survey also contained two especially relevant free-text questions that elucidate very interesting behaviors:

1. How do you believe the increasing food insecurity would affect you personally?
2. Did you like the video? Do you have any general remarks?

With regard to Question 1, the socioeconomic disparities between the respective student populations become evident. A significant majority of the surveyed Ghanaian participants responded with "A lot" or "It will affect me/my […]," highlighting the tangible threat that food insecurity poses in their context. In contrast, most of the German respondents indicated "Not much" (eher wenig/kaum) or "Not at all" (gar nicht/nicht wirklich), suggesting a lower perceived personal risk. Nevertheless, while a substantial portion of German students did not perceive food insecurity as a direct threat to themselves, many were able to recognize its potential impact in so-called "third world countries." Despite this awareness, the fact that a large proportion of TUM students did not perceive any significant threat—either to themselves or to others—raises a point of concern.

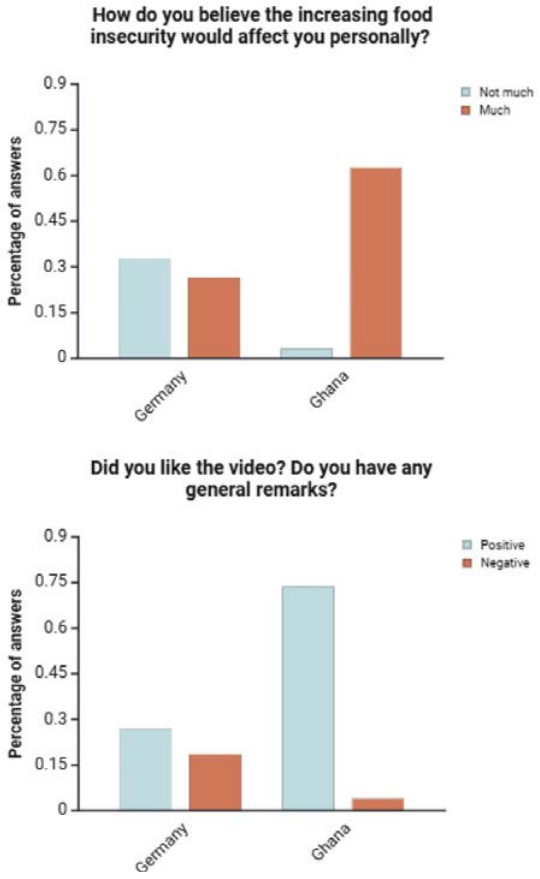


Figure 13: Overview of percentage of answers to Questions 1 and 2 from the surveyed student populations in Germany and Ghana.

With regard to Question 2, responses suggest that Ghanaian participants generally received both video types positively, with several noting that the content effectively addressed the topics of food insecurity and genetic modification. Representative comments included: "It was very impactful," "Yes," "[…] I liked it," and "Yes! Very short and educative." In contrast, a notable proportion of TUM students described the videos as "boring" (langweilig), "condescending," "confusing" (verwirrend), "unserious" (unseriös), or "not very informative" (nicht sehr informativ). These contrasting evaluations may reflect broader cultural differences in communi-

cation expectations and critical reception between the Ghanaian and German-affiliated student groups. Additionally, the comparatively higher perceived danger of food insecurity among KNUST students (cf. Figure 13) may have contributed to a more favorable reception of the video content.

Sociodemographic Correlation of Attitudes Toward GMOs

We compared correlations between demographic factors and attitudes toward GMOs in Germany and Ghana. In both countries, age correlated significantly with trust in GMOs (Germany: $p = 0.0001$; Ghana: $p = 2.47\times10^{-5}$). However, only in Germany did religion and political orientation also correlate with trust (religion: $p = 4.92\times10^{-11}$; politics: $p = 0.0061$), whereas in Ghana, these associations were not significant ($p > 0.26$).

Regarding concerns about food security, only political orientation was significantly associated in Germany ($p = 0.0004$), while in Ghana, both religion and political orientation were significant (religion: $p = 0.0214$; politics: $p = 0.0342$). Age showed no significant correlation in either country.

For emotional responses to GMOs, Germany showed a broader pattern of associations. Age was significantly correlated with anger ($p = 3.23\times10^{-4}$) but not with fear ($p = 0.0056$, above threshold). Religion correlated with both anger and fear (anger: $p = 0.0020$; fear: $p = 2.46\times10^{-5}$). In Ghana, only religion was significantly correlated with fear ($p = 0.0048$); all other associations were not significant ($p > 0.05$). Notably, political orientation did not correlate with emotional reactions in either country.

Summary and Future Goals

Effective science communication plays a more important role than ever in today's age of social media and fast-paced life. While it is essential to present complex facts in a way that the general public can understand, it is also important to consider the emotional impact on the audience. Anxiety as a reaction to intense news can lead to resignation and hopelessness instead of encouraging people to approach problems with confidence and a solution-oriented mindset.

What makes us human is the ability to experience emotions and to decide how we react to them. As part of #class24 of TUMJA, our research group *communicaTUM* set out to investigate how people react to different communication styles on controversial and complex topics. To explore this, genetically modified organisms (GMOs) were chosen as the subject. The same information was presented in two different tonalities: one humorous & inspirational and the other one contemptuous & dramatic.

First, a pilot study was conducted, where participants provided demographic data, religious beliefs, political interests, and attitudes toward science and GMOs. They then read a text about genetically modified bananas. One group received a humorous & inspirational version, while the other received a contemptuous & dramatic version. Afterward, participants were asked how they felt, whether the text had changed their attitude toward GMOs, and whether they felt compelled to take action. In this study, 167 people participated.

In the next stage, the texts were replaced by videos. These were recorded by a professional dubbing artist and featured only minor differences in video footage to ensure comparability. Data was collected through various science outreach events, university gatherings, the DLR school lab, and online surveys, with most participants being 16–25 years old. All responses were collected anonymously to ensure unbiased results. A total of 413 participants took part in the video study, of whom 203 watched the humorous & inspirational video and 210 watched the contemptuous & dramatic video. Both the pilot and final studies were conducted in German.

To add another dimension of comparison, an additional study was conducted in Ghana, at the Kwame Nkrumah University of Science and Technology. For this, the survey was translated into English, and the videos were reproduced. A sample size of $n = 126$ Ghanaian students were actively engaged with the survey, making the total sample size of this study 706 people.

In the German study, participants who watched the contemptuous & dramatic video reported higher levels of worry and anger, while those who watched the humorous & inspirational video felt slightly more in control of the issue. However, when asked whether their stance on GMOs had changed, both groups showed similar responses, with only a slight tendency toward a more positive perception in the dramatic & contemptuous video group. Additionally, the dramatic & contemptuous tone led to a greater inclination to take political action regarding food insecurity, although the effect was moderate. Some participant groups showed more pro-

nounced reactions to the texts than to the videos, regardless of tonality, indicating that individual engagement styles may play a role in how scientific messages are received. While tonality influenced emotional responses, the medium of the message—text vs. video—had a stronger impact on shaping attitudes toward GMOs.

In comparison to our surveyed German sample, the Ghanaian students reacted more positively to almost all questions except to anger (cf. Fig. 8), showing a significantly higher level of engagement, concern, trust and open mindedness than had been analyzed in Germany. Furthermore, the humorous video seemed to achieve more positive results in attitude changes, calmness and political activity (Figs. 9, 11, 12).

In conclusion, our study showed that tonality does influence how people perceive and process information, especially among the scientifically educated German and Ghanaian population. Messages delivered in a dramatic and contemptuous manner can increase engagement and change opinions. Notably, the impact of sociocultural status is very high, as shown by the different attitudes towards the video in Figs. 8-12 and Fig. 13. It is striking to see how the more personally challenged Ghanaian population showed an increased openmindedness, proactiveness and engagement towards the topic of food insecurity and possible GMO solutions.

This raises the broader question of what science communication should aim to achieve. How can we ensure that scientific information is presented in an understandable and neutral way without contributing to the increasing polarization we observe nowadays? Especially in an era where people are overwhelmed with negative and anxiety-inducing information, it is crucial to strike a balance and to convey the seriousness of an issue without amplifying fear and resignation. Future research should further explore how different communication strategies influence public perception and induce proactiveness. The goal should be to make complex scientific information accessible and understandable for everyone while ensuring that people can form their own opinions on controversial topics based on facts rather than emotions or misinformation.

Appendix

cnum	count	interest mean	interest sd	participation mean	participation sd	delegation mean	delegation sd
1	25	1.840000	0.3741657	2.920000	0.6403124	3.240000	0.7788881
2	72	3.777778	0.4186572	1.875000	0.3330398	2.777778	0.5366097
3	170	3.717647	0.4514740	3.194118	0.3966883	2.794118	0.4728994
4	105	3.866667	0.3415650	1.771429	0.4219265	4.000000	0.0000000
5	196	3.811224	0.3923323	3.326531	0.4701448	4.000000	0.0000000

Supplementary Table 1: Summary Values of Cluster Analysis based on Science and Technology Engagement in German student population (TUM). Values marked in blue and orange correspond to the clusters similar to the Ghanaian population from Supplementary Table 2.

cnum	count	interest mean	interest sd	participation mean	participation sd	delegation mean	delegation sd
1	18	3.833.333	0.3834825	3.000.000	0.0000000	4.000.000	0.0000000
2	2	2.500.000	21.213.203	1.000.000	0.0000000	2.000.000	0.0000000
3	52	3.942.308	0.2354355	4.000.000	0.0000000	4.000.000	0.0000000
4	42	3.809.524	0.3974366	3.261.905	0.4450006	2.857.143	0.3541688

Supplementary Table 2: Summary Values of Cluster Analysis based on Science and Technology Engagement in Ghanaian student population (KNUST). Values marked in blue and orange correspond to the clusters similar to the German population from Supplementary Table 1.

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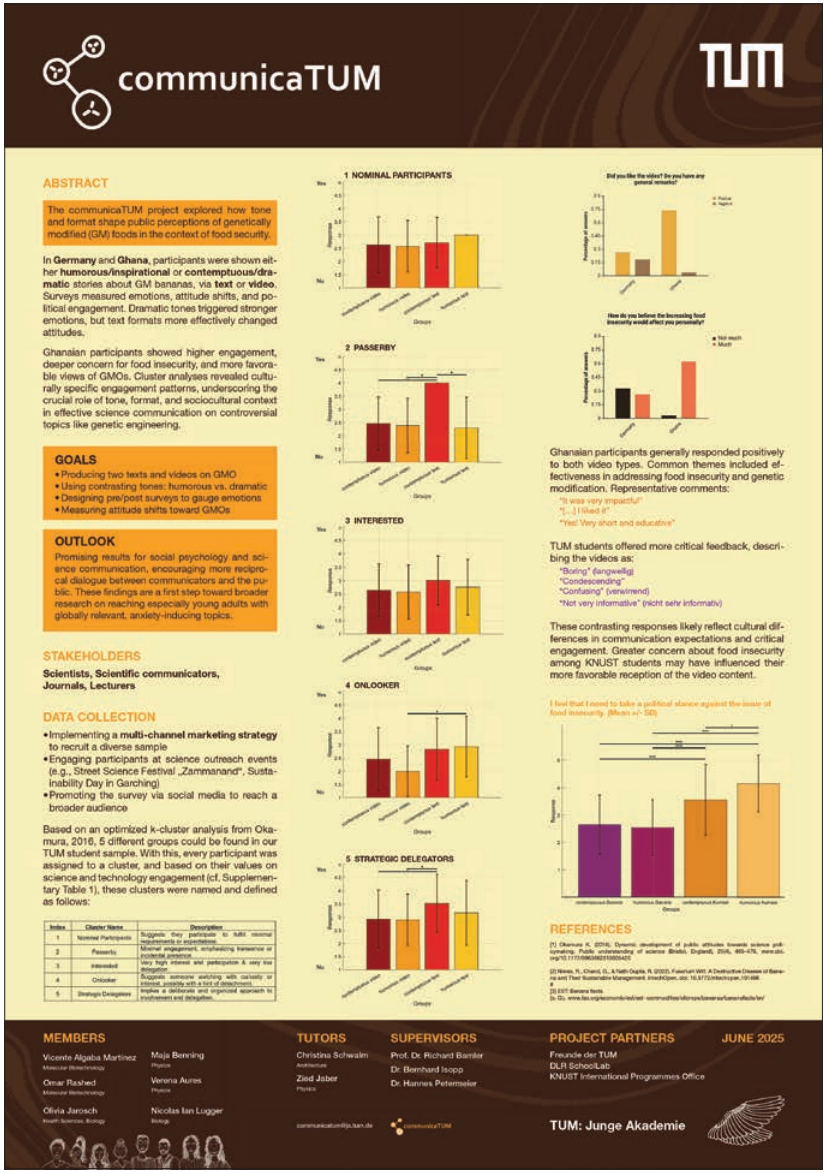
Process description

Project communicaTUM investigated how different tones and formats in science communication influence emotional reactions and perceptions of genetically modified organisms (GMOs). The hypothesis was that tone and format would affect participants differently depending on their background and level of engagement. To explore this, the team developed short videos and texts about genetic modification, using either a humorous or contemptuous tone.

Surveys were designed to collect demographic data, emotional responses, and changes in attitudes toward GMOs. Data was gathered from June 2024 to March 2025 during events such as the TUM Sustainability Day, the Zamanand Festival, and through university lectures at the Technical University of Munich and the Kwame Nkrumah University of Science and Technology in Kumasi during a research trip. Participants completed a pre-survey, engaged with the videos, and answered a post-survey.

The interdisciplinary team from life sciences, physics, and architecture, allowed for an effective division of tasks: content development, statistical analysis using RStudio and MATLAB, and visual design were handled according to each member's academic background. The results showed that "Nominal Participants" responded primarily to the tone, while "Interested" and "Strategic Delegators" were influenced by both tone and format. Overall, a contemptuous tone tended to evoke stronger feelings of anger, while a humorous tone helped foster a greater sense of control, particularly among Ghanaian students.



Self-Reflection communicaTUM

The Team

Project communicaTUM began as one of the largest teams in #class24, with a total of nine members. However, the early days were challenging – three members left within the first few months, which had a significant impact on the team, leading to lower morale and a heavier workload. Despite this, the remaining members quickly developed a strong understanding and connection, which allowed the team not only to survive but to truly thrive.

Although we never had a dedicated team-building event, we've always seen every meeting and seminar weekend as a chance to bond and grow together. We made sure to bring fun into every activity – and we're especially proud of our regular adventures during the seminar weekends!

Furthermore, through our team's active involvement in science fairs, events, and lectures, our bond grew stronger than ever. Even during the cold, rainy days of the Zammanand, we found comfort in each other's company. And, while the work was intense, we all had a blast!

Finally, some of us had the incredible opportunity to visit our partner university in Ghana, the Kwame Nkrumah University of Science and Technology. During our stay, the team carried out a second round of surveys with Ghanaian students, gathering responses from 126 participants. But it wasn't all work! In just a few days, the team managed to explore the country extensively, discovering many of the beautiful sights and experiences Ghana has to offer. It was a deeply meaningful journey that brought us closer – not just through shared sleepless nights, but through a genuine sense of connection and family.

Thanks to everyone for making this experience possible!

- Vicente Algaba
- Verena Aures
- Maja Benning
- Zied Jaber
- Olivia Jarosch
- Nico Lugger
- Omar Rashed
- Christina Schwalm
- Prof. Bamler
- Dr. Isopp